Reviews

A CRITICAL REVIEW OF THE WORLD LITERATURE IN APPLIED MECHANICS AND RELATED ENGINEERING SCIENCE

REVS. 4822-5285 VOL. 11, NO. 12 DECEMBER 1958

GENERAL

Theoretical and Experimental Methods. 658
Mechanics (Dynamics, Statics, Kinematics) 659

MECHANICS OF SOLIDS

Servomechanisms, Governors, Gyroscopics 659
Vibrations, Balancing 660
Wave Motion in Solids, Impact 662
Elasticity Theory 664
Experimental Stress Analysis 665
Rods, Beams, Cables, Machine Elements. 665
Plates, Disks, Shells, Membranes 667
Buckling Problems 669
Joints and Joining Methods 671
Structures 671
Rheology (Plastic, Viscoplastic Flow) 674
Failure, Mechanics of Solid State 676
Mechanical Properties of Specific Materials 676
Plasticity, Forming and Cutting 676

MECHANICS OF FLUIDS

Hydraulics; Cavitation; Transport 677
Incompressible Flow; Laminar; Viscous .. 681
Compressible Flow, Gas Dynamics 683
Wave Motion in Fluids 687
Turbulence, Boundary Layer, etc. 689
Aerodynamics of Flight; Wind Forces .. 691
Aeroelasticity (Flutter, Divergence, etc.). 692
Propellers, Fans, Turbines, Pumps, etc... 693
Flow and Flight Test Techniques 695

HEAT

Thermodynamics 695
Heat and Mass Transfer 696
Combustion 703

MISCELLANEOUS

Acoustics 704
Ballistics, Detonics (Explosions) 705
Soil Mechanics; Seepage 706
Micromeritics 707
Geophysics, Meteorology, Oceanography 710
Lubrication; Bearings; Wear 711
Marine Engineering Problems 712

Letter to the Editor, 716
Books Received, 716

Pressure Exchange, Joseph V. Foa, 655

Published Monthly by THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS at Easton, Pa., and edited by Southwest Research Institute with the co-operation of Linda Hall Library.

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Subscription and Production Office: **The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., U. S. A.**

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APPLIED MECHANICS REVIEWS, December 1958, Vol. 11, No. 12. Published Monthly by The American Society of Mechanical Engineers at 20th and Northampton Streets, Easton, Pa., U. S. A. The editorial office is located at the Southwest Research Institute, San Antonio 6, Texas, U. S. A. Headquarters of ASME, 29 West 39th St., New York 18, N. Y., U.S.A. Price $2.50 per copy, $25.00 a year. Changes of address must be received at Society headquarters seven weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-laws: The Society shall not be responsible for statements or opinions advanced in papers or printed in its publications (B13, Par. 4) . . . . Entered as second-class matter, January 11, 1948, at the Post Office at Easton, Pa., under the Act of March 3, 1897. ©Copyrighted, 1958, by the American Society of Mechanical Engineers.

APPLIED MECHANICS REVIEWS

VOL. 11, NO. 12 MARTIN GOLAND *Editor* DECEMBER, 1958

PRESSURE EXCHANGE

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INTRODUCTION

Pressure exchange" used to be defined (1, 2, 7) as the compression of a fluid at the expense of the expansion of another fluid between the same pressure limits. Today the designation is applied to any process whereby a body of fluid is compressed by pressure forces that are exerted on it by another body of fluid which is expanding. The new definition is very broad in that it covers also processes in which the pressure limits of compression and expansion are widely different. Among these are certain mechanisms which were proposed early in the century for the direct transfer of energy from the combustion products to the fresh charge in gas turbines (3), as well as a variety of energy exchange modes that have only recently received attention.

The classic "pressure exchanger" consists of chambers or "cells," each of which is alternately fed, at one end, the "secondary" fluid to be compressed and the "primary" fluid to be expanded. The expanding primary fluid forces the secondary fluid out of the chamber at the other end, and is then itself discharged out of it. The distribution and valving actions required to produce and control these alternate charges, interactions and discharges are obtained by mounting a number of such cells on a rotor which continually brings new cells to positions opposite appropriate stationary inlet and exit ports. Since each port finds substantially identical flow conditions at all the cell ends that come to face it, the flow through the ports is very nearly steady.

QUASI-STATIC EXCHANGE

In a pressure exchange mechanism proposed by Lebre (1), the expansion of a primary gas within cells on one side of the periphery of a rotor forces a "pressure exchange fluid" out of these cells, through stationary passages, into cells on the opposite side, which are occupied by a secondary gas. The stationary passages are arranged to connect the cells containing the primary gas in the earlier stages of expansion with those containing the secondary gas in the later stages of compression, and vice versa, so that pressure exchange occurs in small steps. This type of pressure exchanger is called "quasi-static," because the pressure in each cell is only a function of angular position and is independent of the velocity of the transformation.

When direct contact between primary and secondary fluid is permissible, the interposition of a recirculating pressure exchange fluid is unnecessary and simpler arrangements are possible (4, 5, 6, 7). In a class of quasi-steady pressure exchangers proposed by Von Ohain (6), the cells are carried by the rotor through a pressure exchange sector and through a recharge sector. In the former sector, the primary gas is admitted into the cells at one end through a succession of stationary nozzles of increasing throat area and forces the secondary gas out at the other end. In the recharge sector, the expanded primary gas is discharged from the cells and new charges of secondary gas are taken in. In the application of these exchangers as high-pressure stages in turbomachines, the cells within the pressure exchange sector form, with the combustion chamber, a "sealed room." In steady operation, the entering cells must carry, both in mass and in volume, as much low-pressure air as the leaving cells carry high-pressure hot gas. Therefore, steady operation of this device with isobaric combustion requires that the pressure rise produced by pressure exchange be the same as that which would be produced, on the low-pressure charge, by constant-volume combustion.

WAVE EXCHANGE

The ability of simple waves to produce, under certain conditions, very large changes of pressure per unit change of velocity (8) makes the use of such waves particularly attractive in pressure exchange. This fact was not fully recognized until 1940, when a successful mechanism of pressure exchange based on the utilization of wave processes was proposed by Seippel (2), to be later embodied in the Brown Boveri "Comprex" (9 to 14 incl.). Here compression takes place, again within cells at the periphery of a rotor, in two stages. The first stage is provided by the hammer wave which is produced by sudden closure of the downstream end of the cell; and the second stage by the shock which is generated by the piston-like action of the primary fluid when it is suddenly admitted into the cell. The control of these wave processes, as well as of the subsequent purging and recharging, requires that the valve action resulting from the motion of the cells relative to the stationary ports and shields be carefully timed to the motion of waves and interfaces within the cells.

In most applications of these wave exchangers, the primary is made up of hot combustion products and the secondary of fresh air, and a favorable mismatching of stagnation pressures results from the fact that velocities and static pressures are the same on the two sides of interfaces separating the two gases (15). Furthermore, and for the same reason, the mass flow rate of the secondary through the exchanger may exceed that of the primary by a good margin. Therefore, this type of pressure exchanger lends itself to utilization in looped arrangements as a compressor, when a portion of the secondary flow is energized through combustion, after pressure exchange, to

form the primary flow; or as a gas generator, when the entire secondary flow is so energized but only a portion of the hot gas is recirculated in the exchanger. In the latter form, this device may take the place of high-pressure stages in turbomachines, the balance between work of compression and work of expansion being obtained, for this portion of the cycle, by adjustment of the mass flow rates, rather than by adjustment of the pressure limits. Early workers on the Comprex achieved pressure exchange compression ratios of about 2.5 (10, 11). However, preliminary performance estimates based on acoustic approximations or on the assumption of polytropic transformations in pressure exchange (14) proved to be quite inaccurate even for relatively low pressure ratios. Detailed analyses of wave exchange by the method of characteristics, first carried out by Kantrowitz and his associates (15), added much to the understanding of the operation of these machines in relation to the boundary conditions and led to a notable improvement of their performance (16, 17).

Little is yet known of the flow distortions resulting from centrifugal effects in the rotor passages of wave exchangers. In axial cells, the equilibrium transverse pressure distributions associated with a field of transverse body forces cannot be matched across normal shocks or interfaces. By the use of helical cells, the tangential component of the absolute motion of the gas may be reduced (2) but not eliminated, because the relative velocity in the cells is not constant. In a variation proposed by Darrieus (18), the cellular assembly is stationary and gas flow and wave processes are controlled by rotating the end shields with portions of the ducts leading to the ports. Centrifugal effects are thus confined to steady-flow regions.

Neither quasi-static nor wave exchangers can normally produce the equality of pressure limits which is specified in the original definition of pressure exchange. In the former, because of the stepped character of the process, the amplitude of the pressure change is smaller in the secondary than in the primary fluid; in the latter, mismatching will normally produce the opposite effect. On the other hand, the separate control of the pressure limits may be desirable in some applications. In wave exchangers, this separate control can be achieved by the generation of more complicated wave patterns, through suitable modifications of the timing of valve operation (19). These modifications will normally affect the flow capacity of the device.

Pressure exchangers based on wave processes have recently been shown to have merit as superchargers (16, 17). In their application as high-pressure stages (in looped arrangement with the combustion chamber) in turbomachines (4, 9, 10, 20), i.e., as supercharged gas generators, they have the advantage of permitting very high peak temperatures, because (except in the Darrieus arrangement) all their moving parts are alternately exposed to hot and cold gases. Furthermore, supercharging tends to offset their inherently low flow capacity.

WAVE ENGINES AND WAVE COMBUSTORS

Unsupercharged gas generators of this class, when the discharged gases are utilized to form propulsive jets, are called "external-combustion wave engines." These are usually double-flow engines, the exhaust comprising a low-energy and a high-energy jet. The former is made up of the de-energized primary as it is scavenged out of the cells, and the latter of that portion of the primary which is not re-circulated through the pressure exchanger. Scavenging of the low-energy flow may be promoted by ejector action, with the high-energy jet as the driving flow (21). External-combustion wave engines are believed to be potentially competitive with the turbojet in air and fuel specific impulse but not in thrust per unit area (22).

Considerable attention has been given to a variety of schemes of gas generators in which combustion and pressure exchange take place in the same ducts or cells. A gas generator of this type is called an "internal-combustion wave engine" or a "wave combustor," depending on whether its exhaust is used to produce a propulsive jet or to drive a turbine.

A simple illustration of this form of pressure exchange is provided by the shock which is generated on ignition of a combustible mixture at one end of a tube. The shock is sustained by combustion and travels ahead of the flame, acting as the vehicle for the transfer of energy from the burning gases to the combustible charge. Utilization of this mode of pressure exchange was attempted by Kahane and his associates in the "intermittent ramjet" (23). Higher compression ratios can be obtained by "extended pressure exchange," i.e., by the introduction of suitable delays in the utilization of the explosion-generated waves. For example, some of the waves which are produced by the explosion in each cycle may be used to establish the flow conditions which will permit the generation of a strong hammer wave through interruption of the flow in the next cycle. The interruption of the flow may be produced by the rapid closure of a gate (22, 24) or by the utilization of special transients that are associated with the motion of interfaces through passages of suitably varying cross section (25, 26).

Pressure exchange is entirely of the extended form in the "hammerjet" (22, 27, 28, 29, 30) and in the hammer-wave combustor (31), where wave precompression of the charge is accomplished by a single sweep of a hammer wave, to be followed by combustion at substantially constant volume. The discharge of the combustion products here occurs in two phases—high-velocity expansion and low-velocity purging. The duration of the latter phase is normally the main frequency-determining factor in this type of device. Purging may be expedited by maintaining an adequate pressure drop across the exchanger (either through utilization of ram effects or by supercharging) or, in multitube devices, by the ejector action of the high-energy exhaust.

The determination of the best compression ratio in internal-combustion wave exchangers is complicated by the interdependence of pressure exchange and combustion that characterizes these devices, as well as by the fact that the freedom of choice of combustion modes is far greater in nonsteady than in steady flow (32). The entropy rise associated with pressure exchange depends on the number of cycles during which each particle remains within the exchanger before it undergoes combustion and on the number and strength of the pressure exchange shocks, which in turn depend on the rate and mode of heat release and on the boundary conditions. Pangburn (33) was able to establish a class of pressure exchange modes for minimum overall entropy rise with front modes of combustion. He found that the optimum mode of pressure exchange is, within this class, relatively insensitive to changes of flame speed, but that the thermal efficiency is very sensitive to departures of the pressure exchange mode from this optimum.

A recent study by Fairhall (34) has revealed great variations in the rate at which internal-combustion wave engines approach periodic operation, depending on the engine configuration and on the initial conditions. These results cast serious doubt on the reliability of any performance estimate based on analysis of a few initial cycles by the method of characteristics.

Most experimental work in this area has been concerned with the problems of combustion and cyclic reignition by "hot boundaries," and special attention has recently been given to the purging of the boundary layer around these boundaries to expedite their contact with the fresh charge in each cycle (26, 35).

AUGMENTATION

Wave exchange processes play an important role in the transfer of energy from the hot combustion products to a secondary flow of cold air in the exhaust of intermittent jet engines—a transfer which can produce a considerable augmentation of thrust under certain conditions (22). The spontaneous occurrence of such processes in the tailpipe of most standard pulsejets at low flight speed ("backflow augmentation"), first re-

cognized by Schmidt (36), has been the object of several experimental studies (37, 38, 30). Similar processes take place in thrust-augmenting ejector arrangements in which the primary flow is nonsteady (40). Here the transfer of energy takes place by both pressure exchange and mixing, but the former effect usually predominates and theoretical analysis has shown that the energy transfer efficiency can be very high (22). The superiority of this form of augmentation over that of the steady-flow ejector has also been confirmed by experiment (41).

STEADY-FLOW EXCHANGE

The possibility of steady-flow pressure exchange has recently been demonstrated (42, 43, 44, 45). The glancing collision of two flows which are steady with respect to the same frame of reference produces a pressure field which deflects the two flows to a common direction in this frame of reference. To the extent that mixing, diffusion and heat transfer across the interface which is formed between the two flows can be neglected, the two flows are, in this frame of reference, both isoenergetic. In any other frame of reference, however, one of the two flows is found to gain a certain amount of energy and the other to lose an equal amount of energy, as a result of the collision. The energy transfer which is associated with this change of frame of reference is essentially nondissipative. A convenient steady-flow frame of reference for this form of pressure exchange is one which rotates about a fixed axis at a constant angular velocity. Thus, the expansion of a fluid (primary) through skewed nozzles on the periphery of a rotating body will produce compression in another fluid (secondary) flowing around the rotor, and will cause the stagnation enthalpy of this secondary flow to increase in the "absolute" (stationary) frame of reference. The energy acquired by the secondary fluid in this process is extracted entirely or partially from the primary flow, depending on whether the rotor is driven solely by the reaction of the issuing jets or also by other means. The pressure limits of compression and expansion may or may not be the same, depending on initial stagnation states, mass flow ratio and rotor speed, and on the nature of the two fluids. Recent unpublished work by Farrell, Bursik, Cohen and Ruptash at Rensselaer Polytechnic Institute has been aimed at the generation of similar patterns of steady-flow interaction by modified and controlled forms of rotating stall through stationary cascades.

REFERENCES

1 Lebre, A. F., "Process and apparatus for performing conversions of mechanical and thermal energy," U.S. Pat. No. 2,045,152, (1936).

2 Seippel, C., "Pressure exchanger," U.S. Pat. No. 2,399,394, (1946).

3 Stodola, A., "Steam and gas turbines," Peter Smith, New York, 1945, Vol. II, p. 1217.

4 Burghard, H., "Air-pumps," British Pat. 19,421, (1912).

5 Wydler, J. J., "Engine superchargers," U.S. Pat. 2,264,126, (1941).

6 Von Ohain, H.J.P., "Report on a special gas turbine principle," ASTIA Rep. ATI no. 31 133, Mar. 1948.

7 Poggi, L., "Scambiatori di Pressione Semistatici e Loro Possibili Applicazioni," *Termotecnica* Mar. 1953; and "The theory of semi-static pressure exchangers," Selected Papers on Engineering Mechanics, Von Kármán Tribute Volume, London, Butterworths, 1955, 83-101.

8 Kantrowitz, A., "One-dimensional treatment of nonsteady gas dynamics," High-speed aerodynamics and jet propulsion, Vol. III, Sect. C, Princeton University Press, 1958, p. 364.

9 Seippel, C., "Gas turbine installation," U.S. Pat. 2,461,186, (1949).

10 Meyer, A., "Recent developments in gas turbines," *Mech. Engng.* **69**, 273-277, Apr. 1947.

11 Pfenninger, H., "Where the gas turbine will fit in future power fields," *Power* **91**, 86(24)-89(27), Jan. 1947.

12 Real, R., "The 3000 kw gas turbine locomotive unit," *Brown Boveri Rev.* Oct. 1946.

13 Hussmann, A., "The Comprex," Central Air Document Office, Tech. Rep. no. F-TR-1189-ND, ATI no. 38 398.

14 Barry, F. W., "Introduction to the Comprex," *J. appl. Mech.* **17**, 1, 47-53, Mar. 1950; AMR **4** (1951), Rev. 895.

15 Kantrowitz, A., "Heat engines based on wave processes," ASME Ann. Meet., New York, Nov. 1948. Preprint.

16 Burri, H. U., "Nonsteady aerodynamics of the Comprex supercharger," ASME Pap. 58-GTP-15, 1958.

17 Berchtold, M., and Gardner, F. J., "The Comprex. A new concept in diesel supercharging," ASME Pap. 58-GTP-16, 1958.

18 Darrieus, G., "Pressure exchange apparatus," U.S. Pat. 2,526,618 (1950).

19 Waleffe, J., "Drucktransformer, insbesondere für Gasturbinenanlagen," Swiss Pat. 315,430 (1956).

20 Müller, M. A., "Zellenradschleuse für Strahltriebwerke," German Pat. 916,607(1954); and "Gasturbinentriebwerk bzw. Strahltriebwerk," German Pat. 924,845 (1954).

21 Jendrassik, G., "Jet reaction propulsion units utilizing a pressure exchanger," U.S. Pat. 2,757,509 (1956).

22 Foa, J. V., "Intermittent jets," High-speed aerodynamics and jet propulsion, Vol. XII, Sect. F, Princeton University Press, 1958.

23 Kahane, A., Marino, A. A., Messinger, C. W., and Shafer, H. J., "A theoretical and experimental investigation of the feasibility of the intermittent ramjet engine," Princeton Univ., Project Squid Tech. Rept. PR-45-R, 1952.

24 Project Squid Annual Progress Rept., 1950, pp. 7-10.

25 Foa, J. V., "The R.P.I. wave engine," Rensselaer Polytech. Inst., Tech. Rept. TR-AE 5409, 1954.

26 Lopez, H. J., and Jensen, R. E., "Summary progress report on the experimental investigation of the R.P.I. wave engine," Rensselaer Polytech. Inst., Tech. Rept. TR-AE 5801, Feb. 1958.

27 British Pat. Spec. 606,544 (1948).

28 Project Squid Quarterly Progress Rept., Oct. 1, 1950.

29 Bitondo, D., and Kumm, E. L., "Preliminary performance studies of the multi-jet," Aerophysics Development Corp., Rept. no. 2000-1-R1, Jan. 24, 1953.

30 Bitondo, D., Knuth, E. L., and Hedges, C. P., "Final Technical Report on the Development of the multi-jet engine," Aerophysics Development Corp., Rept. No. 2003-1-R5, Oct. 1, 1954.

31 Goldstein, A. W., Klapproth, J. F., and Hartmann, M. J., "Ideal performance of valved combustors and applicability to several engine types," *Trans. ASME* **80**, 5, 1027-1036, July 1958.

32 Pangburn, D. F., and Foa, J. V., "An extension of the Chapman-Jouguet gasdynamics of combustion," Rensselaer Polytech. Inst., Tech. Rept. TR-AE 5402, 1954.

33 Pangburn, D. F., "A comparison of combustion modes in intermittent jet engines," Rensselaer Polytech. Inst., Tech. Rept. TR-AE 5504, 1955.

34 Fairhall, R. S., "A theoretical investigation of the effects of changes of shape on the operation of the R.P.I. wave engine," Rensselaer Polytech. Inst., Tech. Rept. TR-AE 5703, 1957.

35 Bitondo, D., Thomas, N., and Perper, D., "Nonstationary combustion studies," Aerophysics Development Corp., Rept. No. AFOSR-TN-57-454, ASTIA no. 136 444, Sept. 1957.

36 Schmidt, P., German Patents 523 655 (1930) and 567 586 (1934).

37 Sutton, G. P., "Backflow determination on aeroresonator," Aerojet Engineering Corp., RTM-16, 1945.

38 Berggren, W. P., Coxe, W. K., and McRoberts, G., "Results of certain experiments on conventional pulsejets and related devices," Aerojet Engineering Corp., Rept. 67, 1946.

39 Bertin, J., and Salmon, B., "Quelques Résultats Obtenu à la S.N.E.C.M.A. dans l'étude des Pulsoréacteurs," Agardograph 15, London, Butterworths, 1957, 122-132.

40 Rudinger, G., "A problem arising in the performance analysis of the ducted pulsejet," Proc. First natl. Congress appl. Mech., 1951; New York, ASME, 1952, 935-939.

41 Bertin, J., "Dilution Pulsatoire sur Réacteur," *C.R. Acad. Sci., Paris* **240**, p. 1859, 1955.

42 Foa, J. V., "A new method of energy exchange between flows and some of its applications," Rensselaer Polytech., Inst. Tech. Rept. TR-AE 5509, Dec. 1955.

43 Stern, I., "A comparison of two methods of direct energy transfer in two-phase steady flow systems," M.A.E. Thesis, Rensselaer Polytech. Inst., Oct. 1956.

44 Wilkinson, W. H., Carey, A. W., Jr., and McCrory, R. J., "Summary report on a feasibility study of the Foa vaneless turbocompressor applied to a double-loop refrigeration cycle," Battelle Memorial Inst., Dec. 1956.

45 Oskay, V., "Analysis of two flow fields in nondissipative interaction," Rensselaer Polytech. Inst., Tech. Rept. TR-AE 5711 (AFOSR-TN-58-334, AD 154 238), Jan. 1958.

Theoretical and Experimental Methods

(See also Revs. 4834, 4846, 4847, 4889, 4901, 4943, 4986, 5020, 5091, 5092, 5093, 5107, 5108, 5147, 5155, 5171)

Book—4822. Sedov, L. I., Methods of similarity and dimensional analysis in mechanics [Metody podobiya i razmernosti v mekhanike], Moscow, Gosudarstvennoe Izdatel'stvo Tekhniko-Teoreticheskoi Literaturya, 1957, 375 pp.

This is the fourth edition of the *sui generis* remarkable book written by the Chairman of the Interdepartmental Commission on Interplanetary Communications. Its first edition appeared in 1943. Compared with the third edition, it contains some additions to chapter II. Chapter IV and Sec. 6 of chap. V have been rewritten to improve the exposition.

Throughout the book, which is very readable, author shows a highly commendable awareness of the part played by a good understanding of the physical details of a process when its analysis by dimensional methods is undertaken. In addition, he shows a rare grasp of an extremely wide range of branches of applied mechanics (using the word in its widest sense).

The book begins with a chapter on the general theory of dimensions for physical quantities. It is the weakest chapter in the book and constitutes a rather superficial introduction into the subject. Notoriously, the study of dimensional analysis arouses many questions in the mind of a thoughtful student and a good expositor should anticipate and answer them as he goes along. This the author has failed to do, which is surprising in view of the existence of a Russian translation of P. W. Bridgman's excellent booklet, both known to and quoted by the author. In particular, the relation between dimensional analysis and the conventions adopted in setting up a system of units have not been brought out too clearly.

A mastery of the subject matter of the book can be fostered in the mind of the student either through a very rigorous exposition of fundamentals or through drill and repeated application to particular problems. The author has chosen the second, to the reviewer less satisfactory, way, because the catalog of problems and their solutions rather than the fundamental principles become the essential part of the book. He gets into his stride and progressively "warms up" to the subject with each succeeding chapter.

Chapter II on similarity, theory of models, and examples of the application of the theory of similarity, contains a good selection of general examples, many of them from the field of fluid dynamics. In section 5 it discusses the famous Rayleigh paradox and gives a satisfactory, if uninspired but original, explanation.

Chapter III, on applications to the theory of viscous flow of fluids and turbulence, is adequate. The subject is treated more fully than is usual even in reference books on boundary-layer theory. It ranges from the diffusion of vorticity to applications in the statistical theory of turbulence which have been so vigorously developed in the USSR (e.g. Loitsianskii).

The last two chapters, chap. IV on one-dimensional, nonsteady flows of a gas and chap. V on applications to problems in astrophysics, could almost stand by themselves. They occupy more than half of the book, are excellent in their exposition, and are unusual in the breadth of coverage. They include a very complete introduction to the application of dimensional analysis in nonsteady gas dynamics, much of which is new to a western reader. Many of the particular solutions have been worked out in the U.S.A., England and Germany, but this is the first *organized* presentation of the subject and carries it much further than has ever been done before.

The book ought to be translated into English and made more generally available. The person who undertakes this task will have made a very worthwhile contribution.

J. Kestin, USA

Book—4823. Oberhettinger, F., Tables of Fourier transformation, [Tabellen zur Fourier Transformation], Berlin, Springer-Verlag, 1957, x + 214 pp. DM 39.5.

Author's work is unquestionably the broadest set of tables published on the Fourier integral transform to date, containing approximately 1800 pairs from a very wide variety of special functions. A large number of the pairs are due to the author and are published for the first time. The tables form a natural extension of the Bateman Project work on Fourier transforms, to which the present author contributed [AMR **7** (1954), Rev. 2056].

The format is much the same as the earlier Bateman Project book. The tables are presented in three chapters, the first and second of these containing the cosine and sine pairs respectively. These chapters parallel one another in their division into sections dealing with the individual special functions. The third chapter presents exponential Fourier-transform pairs for a limited number of functions that are not symmetric, and hence do not become sine or cosine pairs. An appendix contains definitions of the various special functions appearing in the tables, and a bibliography of the important theoretical works and earlier tables also is included. The book forms volume 90 of the well-known mathematical series "Die Grundlehren der Mathematischen Wissenschaften in Einzeldarstellungen."

It is obvious that these tables are an important addition to the literature on operational mathematics.

J. Miklowitz, USA

4824. Titchmarsh, E. G., On the eigenvalues in problems with spherical symmetry, *Proc. roy. Soc. Lond.* (*A*) **245**, 1241, 147-155, June 1958.

Author has previously proved [*Quart J. Math.* **2**, 5, 228-240, 1940] that if $q(x)$ is continuous and tends to infinity as $x \to \infty$ and as $x \to -\infty$, the eigenvalues $\lambda = \lambda n$ of the one-dimensional equation

$$(d^2\psi/dx^2) + [\lambda - q(x)]\psi = 0 \quad (-\infty < x < \infty)$$

are the roots of equations of the form

$$\int_{X'}^{X} [\lambda - q(x)]^{1/2} dx = (n + \tfrac{1}{2})\pi + \delta n \quad (n = 0, 1, \ldots)$$

where X and X' are the positive and negative roots of the equation $q(x) = \lambda$, and δn is small when n is large. In this paper author shows by the same method that the eigenvalues associated with the equation

$$\nabla^2\psi + [\lambda - q(r)]\psi = 0$$

in three dimensions, where $q(r)$ is a function of r only, not on the angle variables θ and φ, and tends to infinity as $r \to \infty$, are the roots of the equations of the form

$$\int_0^R [\lambda - q(r)]^{1/2} dr = (\tfrac{1}{2}l + n + \tfrac{1}{4})\pi + \delta n,$$

where l and n are integers, and δn is small when n is large.

G. C. K. Yeh, USA

4825. Lanczos, C., Iterative solution of large-scale linear systems, *J. Soc. indust. appl. Math.* **6**, 1, 91-109, Mar. 1958.

Paper is an amplification and extension of material on same subject given in author's book, "Applied analysis" [AMR **10** (1957), Rev. 2014]. Iterative technique finds solution directly without matrix inversion. Method uses a polynomial matrix operator based on the recurrence relation of the Chebyshev polynomials of the first kind. Experiments with small-scale matrices indicate that round-off error does not increase with the number of iterations. Experiences with large-scale matrices are not yet available.

Y. L. Luke, USA

4826. Vicolovius, R., Contribution to method of Diaz and Greenberg (in German), *ZAMM* **37,** 11/12, 449–457, Nov./Dec. 1957.

By means of the hypercircle method due to Synge it can be shown that the Diaz-Greenberg method may also be applied to boundary-value problems of a more general character. The proof is given for fourth-order boundary-value problems. The method is illustrated by a numerical example and compared with the Maple-Synge method. Finally, some further problems are mentioned to which the method may be applied.

From author's summary by R. M. Evan-Iwanowski, USA

4827. Norden, P. V., Curve fitting for a model of applied research and development scheduling, *IBM J. Res. Devel.* **2,** 3, 232–248, July 1958.

Analysis of the research and development process has suggested improved techniques for estimating the anticipated effort requirements for engineering projects. Logistic growth curves have been fitted to the time distribution of cumulative man-hours, and an effort-distribution array permits the extraction of meaningful information from historical cost records. These provide a consistent basis for adjusting current project schedules and making further estimates. From author's summary

4828. Fine, M., Standardised polynomials for curve fitting, *J. roy. aero.* Soc. **62,** 567, 212–215 (*Tech. Notes*), Mar. 1958.

4829. Taylor, E. S., An example of system design by logic, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-60, 25 pp.

The use of Boolean algebra and logic is demonstrated in the design of special alarm circuitry for a process stream analyzer.

From author's summary

4830. Norbury, J. F., and Platt, A., A simple method of constructing duct models for the electrolytic tank, *J. roy. aero. Soc.* **61,** 563, 775–776, Nov. 1957.

4831. Greenberg, R., Techniques of flight simulation for ramjet engines, *Jet Propulsion* **28,** 5, 308–314, May 1958.

Mechanics (Dynamics, Statics, Kinematics)

(See Revs. 4849, 5101, 5261, 5264)

Servomechanisms, Governors, Gyroscopics

(See also Revs. 4829, 5095, 5112)

4832. Ludwig, G., and Rollnik, H., Forced vibrations and errors in automatic control systems with time-variable control strength (in German), *ZAMM* **38,** 1/2, 16–20, Jan./Feb. 1958.

This is a highly mathematical paper on control systems which reach their final steady state at a certain finite time. In order to realize this the control strength must increase with time. In a previous paper [*ZAMM* **37,** 11/12, 457/470, Nov./Dec. 1957] the authors gave the general differential equation for such systems and investigated the properties of the homogeneous equation. In the present paper the inhomogeneous equation determining the forced vibrations of the system is considered. Expansions for the deviation of the control system are given both for the initial and for the final stage of the control process.

A. I. van de Vooren, Holland

4833. Bashkirov, D. A., Method of construction of transition processes in nonlinear systems of automatic regulation (in Russian), Tr. Vses. soveshch. po teorii avtomat. regulirovamiya, **2.** Moscow-Leningrad, Izd-vo Akad. Nauk SSSR, 1955, 82–95; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 119.

A method is described for the construction of transition processes in linear and nonlinear systems of automatic regulation. The basis of the method consists of the use of a graphic construction of processes in the elementary members of the regulation systems—integrating and aperiodical.

S. I. Bernshtein

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4834. Kagan, B. M., The frequency-response method of determining the derivatives of the transient-response function (in Russian), *Automation and Remote Control* **17,** 11, 1035–1037, 1957. [Translation of *Avtomatika i Telemekhanika* **17,** 11, 1161–1164, Nov. 1956. Copies obtainable from Consultant's Bureau, Inc., New York City.]

4835. Becker, H., Remarks on the stability criteria of Hurwitz (in German), *Regelungstech.* **5,** 6, 205–206, 1957.

4836. Shinbrot, M., and Carpenter, Grace C., An analysis of the optimization of a beam rider missile system, *NACA TN* 4145, 29 pp. + 4 figs., Mar. 1958.

Using some earlier theoretical results [*NACA TN* 3791, 1956] an integral equation for the impulse response is derived minimizing the distance error between target and missile, if target is starting an additional movement with constant acceleration after the missile has been fired. For comparatively large values of time, simple expressions for the optimum impulse response and transfer function are indicated; but the necessary missile accelerations are so high that the system becomes unsatisfactory. An alternative form of the impulse response and transfer function is proposed where the mean square of missile accelerations can be prescribed. An algebraic transfer function of the fifth order is actually displayed and the corresponding mean square of accelerations as a function of the relative distance error is presented in a chart. A. Kuhelj, Yugoslavia

4837. Takeda, S., Theoretical and experimental investigations of aircraft rate-of-climb indicators (in Japanese), Tech. College, Hosei Univ., Tokyo Rep. no. 2, 73 pp. + 11 pp. English summary, Dec. 1957.

4838. Kuljian, H. A., and Chen, H. S. C., Flow modulator for K-F direct contact regenerative heater system, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-48, 12 pp.

Modern steam power plants using the "K-F" open feedwater heating cycle can do away with a complicated interstage control system by use of a modulator for each heater. A mathematical analysis is shown with curves for 100 and 25% load on a 150,000 KW unit. Outlook is for simplified, less expensive, and more efficient central stations; therefore, electricity at less cost.

From authors' summary

4839. Ransford, G., and Arnaud, P., Optimization of the parameters of a hydraulic turbine governor, taking account of the grid inherent stability factor and the turbine (efficiency/opening) droop. Case of medium specific speed Francis turbine (in English), *Houille blanche* **13,** 3, 205–219, May–June 1958.

After discussing the inadequacy of methods proposed hitherto for choosing the parameters of turbine governors, authors use a new method to determine the optimum operating values, taking account of the favorable influence of the grid (load/frequency)

droop or inherent stability factor as well as of the adverse effect of the (efficiency/turbine opening) droop. The results are given in graphical form. Article concludes with a numerical application of interest. From authors' summary

4840. Shashkov, A. G., Theory of an oil-actuated control device of the "nozzle-vane" type (in Russian), *Automation and Remote Control* **17**, 11, 1000–1019, 1957. [Translation of *Avtomatika i Telemekhanika* **17**, 11, Nov. 1956. Copies available from Consultant's Bureau, Inc., New York City.]

Equations are derived for a control device of the "nozzle-vane" type; the actuation of the device is analyzed, and its transfer function is determined while taking the variability of the consumption coefficient into account. A method is proposed for selecting the parameters of the control devices; the method is based upon the engineering requirements imposed upon its static and dynamic responses. From author's summary

4841. Dimtriev, V. N., and Shashkov, A. G., The force action of a jet upon a vane in pneumatic and hydraulic control elements of the nozzle-vane type, *Automation and Remote control* **17**, 7, 617–627. [Translation of *Avtomatika i Telemekhanika.* Copies obtainable from Consultants' Bureau, Inc., New York, N. Y.]

Paper provides the results of the theoretical and experimental investigation of the force action of a jet upon a vane in pneumatic and hydraulic control elements of the nozzle-vane type. The formula is derived for determining the force which acts upon the vane. The experimental investigation is described, and the effect of various parameters on the magnitude of the force is described. An experimental verification is made of the theoretically obtained function. From authors' summary

4842. Spears, C. A., Electronically controlled machine tools in service, with special reference to coordinate-setting horizontal boring machines, *J. Electron. Control* **3**, 5, 514–530, Nov. 1957.

4843. Strohl, H., Theoretical investigations of hydraulic copying systems (in German), *Machinenb.-Tech.* **6**, 9, 479–486, Sept. 1957.

4844. Faber, S., Qualitative simulator study of longitudinal stick forces and displacements desirable during tracking, *NACA TN* 4202, 11 pp. + 11 figs., Feb. 1958.

In this study in which an airplane simulator with one degree of freedom (pitch) was used, results were determined for three conditions of airplane dynamics. For an undamped natural frequency of 1/2 cps with a damping ratio of 0.8, low stick-force gradients and stick-displacement gearings were desired. For an undamped natural frequency of 1/2 cps with a damping ratio of 0.18 and for an undamped natural frequency of 1 cps with a damping ratio of 0.11, moderate longitudinal stick forces and displacements were desired. From author's summary

4845. Idzerda, H. H., and Ensing, L., Electronic simulators for the solution of control problems (in German), *Regelungstech.* **5**, 199–204, 1957.

Vibrations, Balancing

(See also Revs. 4832, 5016, 5029, 5107, 5110, 5203, 5265)

Book—4846. Jacobsen, L. S., and Ayre, R. S., Engineering vibrations, with applications to structures and machinery, New York, McGraw-Hill Book Co., Inc., xii + 564 pp. $10.00.

This is a first-rate book, and one which has long been needed, as it emphasizes the modern approach to the subject of engineering vibrations. Thus, problems of transient response and of nonlinear vibration are given (nearly) equal consideration with problems of harmonic vibration. This broad treatment is found to be feasible by employing a simple, but very general, technique which at the same time provides an exceptionally clear physical insight into the problem of dynamic response, namely, the phase-plane method of graphical integration of differential equations.

Phase-plane methods have long been employed in physics and mathematics as a valuable aid in the study of the *behavior* of certain solutions of differential equations, particularly in the neighborhood of singular points. It is this latter aspect which has proved so important in the development of nonlinear mechanics theory. However, more recently the phase-plane concept has been developed into a truly valuable tool for the *integration* of differential equations, the authors of the present volume having played an important part in this development. Thus a more-or-less systemized technique for treating harmonic, nonharmonic, and transient vibrations forms the essential basis for the present book.

Obviously, a single technique will rarely serve most efficiently for *all* problems which may be encountered; therefore the book includes also strictly analytical methods for solving equations of motion, energy methods for finding natural frequencies, and numerical methods for analyzing multimass systems. Many examples of practical interest are worked out in considerable detail, using these techniques.

This book is not only distinguished for its comprehensive treatment of the phase-plane method, and its application to a very wide variety of problems, but for the excellence and detail of the graphical constructions and for the wide scope of the bibliography. This book will certainly prove of great interest and value to all students and workers in the field of engineering vibrations.

H. N. Abramson, USA

4847. Magnus, K., Connection between different approximation methods used for the solution of nonlinear vibrations (in German), *ZAMM* **37**, 11/12, 471–485, Nov./Dec. 1957.

A comparison is made among the methods most commonly used for the analysis of oscillations in nonlinear systems. It is demonstrated that they differ only superficially and that they lead to identical results. The methods are: (1) The equivalent linearization of Krylov and Bogolyubov; (2) The variation of constants of van der Pol; (3) The describing function method of Kochenburger; (4) The least-squares linear approximation to the nonlinear systems; (5) The method of Ritz and Galerkin with sinusoidal approximating function; and (6) By reference to AMR **9** (1956), Rev. 52, the first-order perturbation theory of Poincare. Each of these methods in effect replaces the given nonlinear system by a suitable linear one. This paper shows that the linear substitute can be written in a form in which its coefficients are the same, regardless of which method is used to derive them.

Method (5), it is pointed out, is the most flexible because it allows a choice of approximating function. This can be utilized in the analysis of strongly nonsinusoidal (e.g., relaxation) oscillations for which the other methods are notoriously inadequate. Two examples of such analyses are given.

R. Drenick, USA

4848. Myshkis, A. D., Accuracy of approximate methods of analysis of small nonlinear free oscillations with one degree of freedom (in Russian), Vopr. dinamiki i dinam. prochnosti no. 1, Riga, Izd-vo Akad. Nauk Latv. SSR, 1953, 139–164; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 92.

A comparison is made of the precise and approximate solutions of the equation

$$\ddot{x} + f(x) = 0 \qquad [1]$$

where $f(x)$ is the given function. Author is interested in the

smallest possible positive value $t = \tau$, when the solution of the equation, determined by the conditions

$$x(0) = A,\ \dot{x}(0) = 0 \qquad (0 < A < A_0) \qquad [2]$$

will become zero. It is assumed that $f(x)$ for $0 < x < A_0$ breaks down into a stepped series of the form

$$f(x) = x^k(a_0 + a_1 x + a_2 x^2 + \dots) \qquad (a_0 > 0) \qquad [3]$$

Three approximate formulas are investigated: (1) the formula based on the substitution of curve $f(x)$ by a linear expression connecting the beginning of the coordinate with point $(A, f(x))$; (2) the formula of N. M. Krylov and N. N. Bogolyubov; (3) the formula based on the method of direct linearization, submitted by Ya. G. Panovko. Comparing the first terms of the expansion of τ into a stepped series A, author deduces on the strength of numerical comparisons for variables k, that in the case of strong nonlinearity (k appreciably differs from 1) the best approximate formula is found to be the formula of the method of direct linearization, while for weak nonlinearity (k is close to 1) the above method is inferior, as regards accuracy, to the formula of N. M. Krylov and N. N. Bogolyubov, while retaining its advantage as regards simplicity. The modified method of direct linearization, put forward by author, is better as regards accuracy than other methods, for all values of $k = 1$. V. P. Il'in

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4849. Pailloux, H., Orthogonal positions of a dynamical system (in French), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **5,** 274–285.

A classical demonstration of a classical result: the normal modes of a linear undamped vibratory system are orthogonal.

S. H. Crandall, USA

4850. Matschinski, M., Fluctuations in mechanical phenomena (in French), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **5,** 109–122.

Author gives a new approach to the theory of fluctuations (spatial, temporal and parametric) in mechanical phenomena and illustrates his point of view by examples taken from the theory of the potential, wave theory, hydrodynamics, and the theory of elasticity. For the details of exposition and bibliography the reader is referred to the paper itself.

B. Leimanis, Canada

4851. Doeinck, E., Vibration with several degrees of freedom (in German), *Bauingenieur* **32,** 5, 165–169, May 1957.

4852. Higuchi, S., and Iinuma, K., Behavior of the node of an elastic beam during stationary vibration, *J. Franklin Inst.* **265,** 4, 309–316, Apr. 1958.

The property of immobility of the node of an elastic beam in a state of stationary vibration is investigated experimentally. Photographs have been taken of the movement of the node and its neighboring points of an elastic beam in stationary vibration. The mechanism of the behavior of the node is explained qualitatively. H. Bergh, Holland

4853. Boyce, W., and Handelman, G., Vibrations of twisted beams, II, Rensselaer Polytech. Inst. AFOSR TN-57-773 (RPI Math. Rep. no. 11), 22 pp. + 9 refs., Dec. 1957.

Paper is a sequel to a previous paper [R. C. DiPrima and G. H. Handelman, *Quart. appl. Math.* **12,** 241–259, 1954] dealing with the equations of motion which govern the flexural vibrations of a twisted beam having a straight center line and rotating about an axis perpendicular to the centerline. One end of the beam is elastically supported at the axis of rotation, the other is free. Such a beam is particularly of interest as an idealization of a propeller blade. The differential equation of motion differs from the standard equation for flexural vibrations by the presence of two terms proportional to the square of the speed of rotation. Paper discusses various implications of this equation. According to the minimum principle, the lowest eigenvalue is approached by minimizing the Rayleigh quotient. Authors discuss various mathematical questions related to this quotient. Results of analysis are applied to various practical problems. It is shown in particular that resonance between speed of rotation and fundamental propeller blade frequency arises from inclination of the blade section to the plane of rotation, rather than from variable section properties. M. C. Junger, USA

4854. Julius, R. S., and Ranta, S., Normal mode analysis of beams of non-uniform cross-section, with tabulated results for some linearly tapered clamped-pinned beams, *Nat. aero. Establ. Canad.* LR. 210, 14 pp. + 6 tables + 21 figs., Sept. 1957.

In the standard analysis of a beam undergoing flexural vibrations, the beam modes are expressed as the product of a time-dependent and of a space-dependent function. If the beam is of nonuniform cross section, the latter function must satisfy a nonlinear differential equation and can generally not be expressed in terms of elementary functions. Authors replace this spatial differential equation by an integral equation involving a suitable Green's function. The solution to the integral equation is approximated by first replacing the integral equation by a matrix equation, which is then solved by an iteration procedure developed for this problem by the authors. Method is illustrated by analysis of two clamped-pinned beams, one of constant depth and linearly tapered width, and the other vice versa. M. C. Junger, USA

4855. Mettler, E., Forced nonlinear vibration of elastic bodies (in German), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **5,** 5–26.

The nonlinearity of the problem discussed arises from the supposition that the deformations are of such an order of magnitude that they must be taken into account in the equilibrium equations (although at the same time the gradients of the displacements are small enough so that their squares can be neglected with respect to one; the validity of Hooke's law is also accepted). General theory of elastostatic problems of this kind is largely developed [AMR **9** (1956), Rev. 3907], while rather few instances of such elastodynamic problems have been discussed by Russian and German authors. The paper deals with three examples: one concerning the slightly curved bar which is "beating through" under pulsating transverse loading (Durchschlagsproblem) and two problems (Verzweigungsprobleme), relating to a beam loaded with axial pulsating forces and girder with pulsating couples at the ends. An outline of a general theory is also given. This paper by an outstanding pioneer in a new and interesting field of research should stimulate further development of the theory.

D. Radenkovic, Yugoslavia

4856. Gumenyuk, V. S., The free oscillations of plates of variable thickness (in Ukrainian), *Dopovidi Akad. Nauk URSR* no. 2, 130–133, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3444.

By replacement of the partial derivatives in the equation of motion of the plate, with finite differences, the frequency of the fundamental mode of oscillation is determined.

Numerical results are presented for plates in the form of a rectangle and an isosceles triangle, the thickness being regarded as dependent only on one coordinate and varying by a linear law, while the edges of the plate are freely supported.

Ya. S. Uflyand

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4857. Metzmeier, E., Longitudinal oscillation of propeller shafts (in German), *Schiffstechnik, Hamburg*, **4**, 24, 267–269, Nov. 1957.

Solving the fundamental differential equation of longitudinal vibrations for a ship propeller shaft under consideration of two kinds of boundary conditions (rigid and elastic axial pressure bearing), author derives the frequency equation and gives a practical numerical example. Comparison of the natural frequency of the shaft with the eighth-order component of the disturbing axial force shows coincidence and is probably the cause of enlarged axial vibrations of the pressure bearing.

V. Kopriva, Czechoslovakia

4858. Dimentberg, F. M., The stress change in a flexible shaft when passing through the critical speed range (in Russian), "Oscillations in turbine machinery," Moscow, Akad. Nauk SSSR, 1956, 21–48; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3468.

An analysis of the transverse vibrations of a flexible shaft with one unbalanced disk load, in the presence of constant angular acceleration. The mass of the shaft is neglected while the disk is considered as located at the middle of the span (unsupported length) of the shaft, whereby its gyroscopic effect can be neglected.

V. V. Bolotin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4859. Nicolay, B. L., Graphical determination of the frequency of free oscillation of shafts (in Russian), *Nauch. tr. Odessk. vyssch. morekhodn. ucb-shcha* no. 1, 126–132, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3472.

4860. Dimentberg, F. M., Some problems of the bending oscillations of rapidly rotating shafts (in Russian), Thesis, In-t mashinoved. Moscow, Akad. Nauk, SSSR, 1955; *Ref. Zh. Mekh.* 1956, Rev. 5420.

4861. Weigand, A., Damped vibration of a homogeneous chain (in German), *ZAMM* **38**, 1/2, 28–39, Jan./Feb. 1958.

Author considers viscously damped longitudinal vibrations of a homogeneous chain consisting of n equal masses connected with one another by identical springs and dampers. By expressing the complex eigenvalues in trigonometric form, solutions are obtained in closed form for a system of difference equations of motion for free vibration and for forced vibration under harmonic force or displacement excitation. By means of Laplace transform, the transient state is further solved, and, in particular, the effect of a rectangular impulse is discussed.

Y.-Y. Yu, USA

4862. Khivinya, M. V., Small natural vibrations of conical springs of constant pitch (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **16**, 73–80, 1953; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3712.

Expressions are given for determining the rigidity and weight per unit length of a conical spring with a constant pitch. The equation of the unconstrained vibrations of such a spring is derived. For the case when both ends of the spring are constrained, or when one end is gripped and the other free, characteristic equations are developed. Tables are given for the two first roots of the characteristic equations, for different values of the conicity (taper) of the spring, and ratio of weight of load at the end of the spring to the weight of the spring itself. With the boundary conditions as indicated, finite expressions are given for determining the integration constants.

A. V. Shtoda

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4863. Silveira, M. A., Maglieri, D. J., and Brooks, G. W., Results of an experimental investigation of small viscous dampers, *NACA TN* 4257, 21 pp. + 25 figs., June 1958.

Paper gives damping and spring forces for several kinds of dampers used in dynamic model tests, including types in which a piston displaces oil and types in which a rod slides through a silicone fluid. Results show effect on forces of maximum piston velocity, kind of fluid, and temperature. Effects of frequency and amplitude are usually small. Data will be useful to those making such tests.

C. W. Smith, USA

4864. Singh, B. R., and Pearce, C. E., On damping in vibration, *J. Instn. Engrs., India* **38**, 5 (part II), 519–532, Jan. 1958.

4865. Radke, A. O., Vehicle vibration...Man's new environment, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-54, 9 pp.

4866. Ramberg, W., Calibration of shock and vibration pickups, *Noise Control* **3**, 5, 23–33, Sept. 1957.

4867. McGoldrick, R. T., A vibration manual for engineers, 2nd edition, *David W. Taylor Mod. Basin Rep.* R-189, 27 pp., Dec. 1957.

Wave Motion in Solids, Impact

(See also Revs. 4866, 4963)

4868. Ripperger, E. A., and Abramson, H. N., A study of the propagation of flexural waves in elastic beams, ASME Summer Conf., Berkeley, California, June 1957. Pap. 57-APM-11, 4 pp.

Paper compares experimental results obtained from impact of small steel ball striking plane end of circular steel bar eccentrically with the predictions of Pochhammer-Chree and Timoshenko's treatments of flexural wave propagation. Authors show that main pulse can be accurately described by either theory but that a *precursor wave* travelling with dilatational velocity is also detected experimentally. The latter is to be expected from consideration of higher mode propagation in Pochhammer-Chree treatment, but is not predicted in Timoshenko theory. Authors suggest Timoshenko's theory adequate for all but the sharpest impacts.

H. Kolsky, England

4869. Naake, H. J., and Tamm, K., Sound propagation in plates and rods of rubber-elastic materials (in English), *Acustica* **8**, 2, 65–76, 1958.

The known results for the propagation of sound in plates with Poisson's constant $\sigma = 0.5$ (liquids) and $\sigma = 0.35$ (aluminum) are completed by dispersion curves with $\sigma = 0.47$ (rubber). The dispersion curves are easily understandable because of the large difference between the velocities of transverse and longitudinal waves occurring at this value of σ.

Measurements of the propagation of elastic waves in rods of rubber with square cross section in the frequency range 0.1 to 300 kc/s are reported. The amplitude is measured as a function of distance by partly submerging the rod into a water-filled vessel within which a hydrophone is arranged.

The results with respect to phase velocity and attenuation can be explained in terms of the propagation of extensional waves at low frequencies and compressional waves at high frequencies separated by a range with high attenuation.

From authors' summary by M. Harrison, USA

4870. Mitra, M., Disturbance produced in an elastic half-space by an impulsive twisting moment applied to an attached rigid circular disc (in English), *ZAMM* **38**, 1/2, 40–43, Jan./Feb. 1958.

Author reduces problem in cylindrical coordinates for isotropic medium to a solution of

$$\partial^2 u_\theta/\partial r^2 + (1/r)\partial u_\theta/\partial r + \partial^2 u_\theta/\partial z^2 - u_\theta/r^2 = (1/c^2)\partial^2 u_\theta/\partial t^2$$

through arguments of symmetry and the nature of the input (shear stress $\tau_{z\theta} = f(r)\delta(t)$ over disk half-space interface, other surface tractions zero everywhere), c being the distortional wave velocity. Solution in closed form (elliptic integrals) for u_θ is obtained through a double integral transform (Hankel and Laplace) technique. It is evaluated numerically at the boundary ($z = 0$), for several stations r from disk, showing a regularly (almost linear) decaying disturbance with time of finite length, having finite jumps at each end. The amplitudes of the disturbance decrease with an r increase. Solution also shows that (1) u_θ increases, and (2) the duration of disturbance at a station r decreases, as r_0 (disk radius) decreases.

Author also treats case of transverse isotropy in the medium, showing the solution has a form similar to that of the isotropic problem, hence similar results. Problem and mathematical solution are interesting. Reader, however, will have to put up with several typographical errors. J. Miklowitz, USA

4871. Lang, H. A., The nature of axisymmetric wave fields in elastic solids, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-21, 10 pp.

Expressions for the displacements established in an infinite half-space by a concentrated unit impulse which is a step function of time are determined by extending, to the axially symmetric case, the procedure of F. Sauter previously applied to the concentrated line shock in two dimensions. The solution is limited to a surface source. The appropriate equations are generated by a cylindrical harmonic set of waves—doubly infinite in frequency and separation constant. Transform methods are used to satisfy the free stress boundary conditions. A convergent integral in the complex plane of the separation constant is established to eliminate the Bessel functions. The final complex integrals for the displacements exhibit branch points which establish the fact that the displacements involve elliptic integrals of all three kinds. Because of these singularities, the solution for the displacements and stresses separate into three sets which reflect the individual contributions of the dilatational (P) wave, the distortion (S) wave, and the von Schmidt head wave. Integral expressions are derived for the displacements. It is shown that these can be evaluated in closed form. To confirm the method partially, displacements and stresses are derived for an acoustic elastic material (in which only the P-wave is present). The results are used to prove that a pulse in acoustic material travels without dilatation, rotation, or acceleration; as Stokes and Love have observed. Some evidence is presented for the conjecture that wave transmission may depend upon the fact that Poisson's ratio is above or below a critical value, $\nu_{crit} = 0.32$. Expressions for the surface displacements in exact closed form for this problem as well as the buried pulse have been given by Pekeris. From author's summary

4872. Ramberg, L. K., and Irwing, W., A pulse method for determining dynamic stress strain relations (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **8**, 480–489.

Experimental method for determining stress-strain relation for material of long bar is presented. An axial strain pulse is sent through the bar. Strain, strain gradient are determined at given section from wire resistance strain gages attached to the bar. Particle acceleration is determined at same section by differentiating the voltage output of a "velocity" coil wound around the bar and displaced by the pulse relative to a stationary magnetic field.

Method is based upon differential equation of equilibrium only. The stress-strain relation (the tangent modulus at the stress level) results from the tests: it is *not* assumed a priori as in previous methods, some of which are briefly discussed in the paper.

Only preliminary tests are reported, indicating occasional distortion. C. Riparbelli, USA

4873. Wyllie, M. R. J., Gregory, A. R., and Gardner, G. H. F., An experimental investigation of factors affecting elastic wave velocities in porous media, *Geophys.* **23**, 3, 459–493, July 1958.

An experimental investigation has been made of the factors which affect the velocity of vibratory signals in porous media. It is shown from the results of experiments carried out on appropriate natural and synthetic porous systems that the time-average formula previously suggested by Wyllie, Gregory, and L. W. Gardner is of considerable utility. This formula states that

$$\frac{1}{V_M} = \frac{\phi}{V_F} + \frac{1-\phi}{V_R}$$

where V_M = velocity measured, V_F velocity in saturating liquid, V_R velocity in rock solid, and ϕ volumetric porosity fraction. The effects are examined of differential compacting pressures on the applicability of this formula to consolidated and unconsolidated rocks. It is shown that the time-average relationship cannot be applied to determine the total volumetric porosity of carbonate rocks which are vugular and fractured. In such rocks, paradoxically, this circumstance may be advantageous because of the lithological information that may be obtained from an appropriate combination of velocity and nuclear log data.

The effects of oil and gas saturation on velocity have been examined experimentally and are found to be comparatively minor. The combination of velocity data with information from electric logs in order to locate zones of oil and gas saturation is shown to be generally valuable; this is particularly so when holes are drilled with oil-base mud.

Some discussion is given of the possible effects on velocity measurements of the relative wettability of rock surfaces by various liquids.

Owing to instrumental limitations, it cannot necessarily be assumed that measurements made in the laboratory are directly applicable to the interpretation of velocity data obtained under field conditions. From authors' summary

4874. Lieber, P., and Farmer, A., Studies on wave propagation in granular media, *Trans. Amer. geophys. Un.* **39**, 2, 313–321, Apr. 1958.

Experimental studies relating to the propagation and attenuation of disturbances in unconsolidated materials encouraged a theoretical investigation suggesting a mechanism governing propagation in such materials. From these physical considerations it is inferred that a disturbance imparted to a granular material is propagated in two principal parts. One consists of a wave of small amplitude which anticipates a wave of much higher amplitude propagating at a lower velocity. The first wave is called here a precursor and is identified with the viscoelastic deformation of the grains of the unconsolidated material. The second component propagating at a lower velocity and carrying most of the energy imparted by the disturbance is identified with consolidation, accomplished by filling the voids between the grains. It is thus inferred that there would be appreciable dissipation of energy associated with the second wave and little attenuation of the precursor wave. Further experiments were conducted to check

these conclusions. The results of these experiments show the composite wave structure predicted from theoretical considerations.

From authors' summary

4875. Murphy, G., Hausrath, A. H., III, and Peterson, P. W., Response of resistance strain gages to dynamic strains (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles 1957; **8**, 448–456.

Article treats theoretically the distortion of an impulsive signal from a gage of finite length which arises from the differences in strain existing over the gage length at any given instant during the passage of the strain impulse. The gage signal is an integration of these differences over the gage length. Gage is assumed free of mechanical or other response limitation. Experimental confirmation is obtained for pulses having duration of approximately 0.0005 seconds.

C. W. Gadd, USA

4876. Attia, A. Y., Dynamic loading of spur gear teeth, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-32, 7 pp.

Paper presents results of strain-gage investigations conducted on steel spur gears to measure the instantaneous load on the tooth under static and dynamic conditions.

From author's summary

4877. Hall, A. W., Sawyer, R. H., and McKay, J. M., Study of ground-reaction forces measured during landing impacts of a large airplane, *NACA TN* 4247, 21 pp. + 2 tables + 12 figs., May 1958.

Tests were conducted on a large bomber-type airplane to determine the ground-reaction forces imposed on the main landing gear under actual landing conditions. Data were obtained from 30 landings made at vertical velocities up to 8.4 fps and forward ground speeds from 81.0 to 119.5 knots. Vertical, drag, and side forces are presented. Results are presented of the effect of vertical velocity at contact on the vertical force and the variations of coefficient of friction with slip ratio during spin-up for both wet and dry concrete surfaces. A limited amount of side-force data indicating the nature of side-force variation with drift angle and vertical force is presented.

From authors' summary

Elasticity Theory

(See also Revs. 4928, 4929, 4965, 4968)

4878. Prelog, E., Integration of Lame's equation of elastostatics for arbitrary loading on spherical or cylindrical shells of any thickness (in French), 9th Congrès intern. Mecan. appl., Univ. Bruxelles, 1957; **5**, 143–154.

Paper concerns the equilibrium of a complete hollow sphere or cylinder. The differential equations of equilibrium in terms of displacements are written in spherical coordinates. An infinite series solution is formed from a sequence of particular solutions in terms of functions similar to spherical harmonics. Sufficient constants are present to permit the satisfaction of arbitrary conditions on the interior and exterior surfaces of a sphere. No specific problems are solved. Reviewer believes that a more complete and more useful discussion of this problem is given by A. I. Lur'e [AMR 7 (1954), Rev. 3828]. Results of previous treatment of hollow cylinder are cited [*Math. Rev.* **15**, 5, 483, May, 1954].

E. H. Dill, USA

4879. Hajdin, N., A method for the numerical solution of boundary-value problems of elliptical type and its application to certain problems in elasticity theory (in French), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **5**, 261–273.

Author gives here a method for solving numerical problems in a partial differential equation of elliptical type. The method is similar to the method given by Marcus for determining the deflection of the plates, and similarity is emphasized in the two examples here reported; i.e. numerical solutions for a rectangular plate clamped or simply supported at the edges.

G. Supino, Italy

4880. Savruk, M. A., The influence of a circular aperture on the stress condition in a bent semi-plane (in Russian), *Nauch. zap. Lvovsk. politekhn. in-ta no.* 30, 65–71, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3377.

The problem is examined of the bending of a semiplane weakened by a circular hole at a distance b from the edge of the plate and subjected to bending moments M acting at infinity. The edge of the plate and the rim of the hole are free from external forces. The unknown biharmonic functions $w_1^{(1)}(\alpha, \beta)$ and $w_1^{(2)}(\alpha, \beta)$, solving the set problem, are determined from the boundary conditions and the condition at infinity. Knowing the stress function $w(\alpha, \beta)$, author uses known formulas to determine the stresses at the rim of the hole and on the rectilinear edge of the plate. The results are obtained in the form of infinite, rapidly converging, trigonometric series. Numerical examples are given. A similar method is applied to solve the problem of the extension of a semiplane, weakened by a circular hole [see Ya. S. Uffland: "Bipolar coordinates in the theory of elasticity," Gostekhizdat, 1950, p. 212].

N. I. Kalynyak

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4881. Zhitkov, P. N., Plane problem in the theory of elasticity of a heterogeneous orthotropic body in polar coordinates (in Russian), *Zap. Voronezbsk. s.-kh. in-ta* **25**, 1, 263–270, 1954; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2143.

The plane problem is examined of a body possessing cylindrical anisotropy. At the same time, the elastic constants appear as variables. The solutions of the equations obtained are produced in a hypergeometrical series. The results of this work, with insignificant alterations, were published previously. [See *Ref. Zh. Mekh.* 1955, 3174].

A. S. Kosmodamianskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4882. Trostel, R., Thermal stresses in hollow cylinders with temperature-dependent properties (in German), *Ing.-Arch.* **26**, 134–142, Mar. 1958.

Paper contributes to the field of thermal stresses in the region of higher temperatures where the temperature dependence of the material properties is important. A general, closed-form solution of the problem is possible only for the special case of elastic-incompressible materials, which author treats. This case allows a relatively simple and explicit representation of the stresses by means of integrals. These integrals can be evaluated in closed-form in special cases, but they may be evaluated by numerical methods for general cases.

From author's summary by T. P. Torda, USA

4883. Walter, H. E., Deflection of structural elements due to the influence of temperature (in German), *Beton u. Stahlbeton.* **53**, 2, 40–42, Feb. 1958.

The flexure line of a beam which is heated on one side is deduced by compensating the influence of the heating through a bending moment. Mohr's construction is applied to the line of flexure.

L. Foppl, Germany

4884. Raymondi, C., Analysis of twisted Saint Venant bars (in Italian), *Pubbl. Fac. Ing., Univ. Pisa*, (*16a*) **50**, no. 782, 14 pp., 1956.

By direct integration of the basic equations of elasticity author obtains a solution for the problem of the twisted bar involving, for the displacements, six constants on integration. These constants obviously characterize a rigid body motion which is discussed in detail. K. Marguerre, Germany

4885. Resinger, F., Determination of drilling stresses in simple symmetrical problems according to the drill beam method (in German), *Stahlbau* **26,** 11, 321–326, Nov. 1957.

In the theory of torsion of prismatic beams with open profiles as sections—for example the channel profile—the moment of torsion can be approximately compensated by a couple of forces, which act in both fillets of the section. The fillets are to be assumed as beams, which are bent in opposite direction through the forces of the couple. In the first approximation Saint-Venant's portion of the resistance of section can be neglected in comparison with the influence of the bending of the fillets. In the second approximation account is taken of the Saint-Venant drilling stresses. The comparison with the exact theory is satisfactory.
L. Foppl, Germany

4886. Korenov, B. G., A stamp lying on an elastic semi-infinite space whose elastic modulus is a power function of depth, *Soviet Phys.-"Doklady"* **112,** 1/6, 77–81, Jan./Feb. 1958. [Translation of *Dokladi Akad. Nauk SSSR* **112,** 1/6, 823–826, Jan.-Feb. 1957 by Consultants Bureau, Inc., New York, N. Y.]

Author treats title problem for axially symmetric case, with E increasing with depth. Problem is reduced to solution of dual integral equations in line with I. N. Sneddon's "Fourier transforms." Explicit values of contact pressure are given for case of flat stamp. Procedure for extending method to plane problem is discussed. L. V. Colwell, USA

4887. Johnson, K. L., The effect of tangential forces and spin upon the rolling motion of an elastic sphere on a plane (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles 1957; **5,** 233–234.

4888. Tchankvetadze, G. G., The contact problem of an elastic medium (in Georgian), *Trudi Gruz. politekhn. in-ta* 1, 42, 119–124, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3350.

An approximate solution, in the sense of satisfying the boundary conditions, is given for the problem of the compression of a rigid sphere of radius R into the half of a spherical cavity (of the same radius) of a homogeneous and isotropic, elastic medium. This solution is represented by the initial terms of expansions according to Legendre polynomials:

$$P_n(x),\ x = \cos\theta = z/\sqrt{r^2 + z^2}$$

The coefficients of the expansions are found by numerical solution (an example being given) of the linear systems obtained by contracting linear systems with an infinite number of unknowns.
N. A. Rostovtsev
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Experimental Stress Analysis

(See Rev. 4875)

Rods, Beams, Cables, Machine Elements

(See also Revs. 4852, 4853, 4854, 4855, 4860, 4876, 4885, 4927, 4936, 4949, 4967, 4970, 4972)

4889. Clough, R. W., Matrix analysis of beams, *Proc. Amer. Soc. civ. Engrs.* **84,** EM 1 (*J. engng. Mech.*), Pap. 1494, 25 pp., Jan. 1958.

Paper is an elementary application of the matrix force method formulation of the reviewer [see *Aircraft Engng.* **27,** 2, p. 42, 1955; **27,** 3, p. 80, **1955**; **27,** 4, p. 125, 1955; **27,** 5, p. 145, 1955; AMR **10** (1957), Rev. 54. See also *Ing.-Arch.* **25,** 3, p. 174; AMR **11** (1958), Rev. 81. *Aero. Res. Counc. Lond. Rep. Mem.* 3034, Feb. 1956. *Jahrbuch Wiss. Gesellsch. Luftfahrt* 1956, p. 78] to very simple beam examples. The matrix operations leading to the flexibility matrix of simply supported and cantilever beams and the analysis of continuous beams are clearly demonstrated. Following aeronautical practice the shear flexibility of beams is included. The detailed illustrations should prove useful to aeronautical and civil engineers as additional illustrations to the general theory of the quoted references.
J. H. Argyris, England

4890. Lianis, G., and Ford, H., The yielding of notched bars due to bending (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **8,** 235–244.

It is pointed out that a beam to which a gradually increasing moment is applied begins to deform after the plastic zones commencing at the notch on top and free surface at the bottom join. Until then the nonplastic zones constrain deformation. The moment causing deformation is the collapse or limit moment.
A general, theoretical solution, not reported upon here, is claimed to have been accomplished for both the slip-line field and the statically admissible field. This general solution is applied to a V-notched, circularly notched, and rectangularly notched bar. The collapse moment is computed and measured. A constraint factor is calculated from each moment and compared. A series of graphs depicts the close agreement found.
J. P. Vidosic, USA

4891. Barta, J., Determination of the kern of a trapezium (in German), *Acta Techn. Hung. Budapest* **18,** 3/4, 393–398, 1957.

Paper demonstrates simple and straightforward geometric method to find the kern of a general trapeziform cross section.
J. Hult, Sweden

4892. Amen-Zadeh, Yu. A., The bending of circularly-prismatic beam weakened by a prismatic cavity (in Azerbaij.), *Dokladi Akad. Nauk AzSSR* **11,** 9, 595–603, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3394.

The stress conditions are examined for the bending of homogeneous, isotropic, circularly prismatic beam weakened by a prismatic cavity, under the action of a concentrated load directed along a diagonal of the cylinder.

In view of the boundary condition at the circumference and a purely imaginary, auxiliary function introduced therein, a regular function of the cross section of the beam is constructed, analytically continuous outside the circumference and becoming zero at infinity. Allowing for the boundary condition on the square, author has determined the regular function on the exterior of the unit circle corresponding to the representation of the square equalling zero at infinity.

Further, a regular function is found over the cross section of the beam; for determining the unknown coefficients of this function and finding the auxiliary function, an infinite system of linear algebraic equations is constructed. From this system by the method of successive approximations, solutions are found for the first ten equations of the system; only the first four being, in fact, necessary to approximate to a highly accurate solution.

The degree of accuracy of the regular function over the cross section, found by the solution of the abbreviated system of equa-

tions, in relation to the boundary conditions for the problem considered by the author is analyzed.

Further, the values are calculated of the shear stresses in the points of the neutral axis, and the results are compared with the values of the shear stresses found by the equation of D. I. Zhuravsky.

A. K. Rukhadze

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4893. Tchkhikvadze, G. M., The oblique bending of compound prismatic beams by a couple (in Russian), *Soobshch. Akad. Nauk GruzSSR* **16**, 6, 425–430, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3391.

The problem is examined of the nonlinear theory of elasticity, concerning the oblique bending, by a couple, of a prismatic beam composed of different elastic materials, on the assumption that the Poisson ratios of the materials forming the beam are identical. The problem is solved by the method of the small parameter. A solution of the same problem for a more general case is given by R. S. Minassian.

A. K. Rukhadze

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4894. Metsugov, V. Kh., The problem of the transverse bending of a prismatic beam composed of different elastic materials in tension (in Georgian), *Trudi Gruz. politekn. in-ta* **42**, 1, 89–98; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3389.

The interaction is examined between the bending under a transverse force and the tension of a compound, prismatic beam, according to the nonlinear theory of elasticity.

It is assumed that the beam consists of a series of parallel, solid bars, not in contact with each other, surrounded externally by an elastic medium. The lateral surface of the beam is free from external forces, while the components of the displacement vector remain constant.

Applying the method of the small parameter, author reduces the solution of the set problem to the determination of five functions satisfying the Poisson equations, the biharmonic equation, and particular conditions on the contour of the cross section as well as on the boundaries of the internal regions corresponding to the cross sections of the component bars. The components of the displacement vector and stress tensor are determined by introduced functions.

A. K. Rukhadze

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4895. Kutateladze, Torsion and bending under transverse load of a compound beam of different materials whose cross section is bounded by hypotrochoids (in Georgian), Tr. Gruz. politekhn. in-ta **42**, 1, 113–118, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3388.

The problem is examined of the torsion and bending, by a transversely applied force, of a primsatic beam composed of two elastic materials, the cross section of which is bounded by hypotrochoids. It is assumed that the Poisson ratio of the two materials forming the beam is identical, while the modulus of elasticity is in the general case different.

The problem is resolved by the theory of the functions of a complex variable.

A. K. Rukhadze

Courtesy Referativnyi Zhurnal, USSR
Translation courtesy Ministry of Supply, England

4896. Filonenko-Borodich, M. M., The problem of the resistance of a thin bar in an elastic medium (in Russian), "Researches on problems of stability and strength," Kiev, Akad. Nauk USSR, 1956, 52–57; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3601.

The longitudinal stability of a bar with constrained ends situated in an elastic medium is examined. The axially compressing forces are applied at the ends of the bar.

Differing from the direct method of solution suggested for this problem by G. G. Talypov [*Ucb. zap. Leningr. un-ta*, 1944, no. 13], present author uses functions of the form

$$P_m(x) = \cos \alpha_m x - \cos \beta_m x$$

where

$$\alpha_m = \frac{m\pi}{l}; \beta_m = \frac{(m+2)\pi}{l} \qquad (m = 1, 2, 3, \ldots..)$$

and l = length of the bar.

A formula is derived for the critical force for discrete values of the coefficient of elasticity of the (surrounding) medium. For intermediate values of this coefficient, the equation of the upper limit of the critical force is determined by the Ritz-Timoshenko method.

It is demonstrated that in the problem of the resistance to longitudinal compression of a thin-walled tube, the question of end constraint practically does not arise. It is noted that, for the case of the bar, the influence of end constraint is considerable only in the presence of a slight degree of rigidity of the elastic medium.

I. E. Shashkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4897. Nowinski, J., An approximate theory of bending and torsion of straight solid bars (in Polish), *Rozpr. Inzyn.* **4**, 2, 325–348, 1956.

An approximate theory of combined bending and torsion of a solid bar is considered taking the warping of the sections into account. This theory is more simple than the exact theory and represents an intermediate stage between Stevenson's mathematical theory and the elementary theory of strength of materials. The main simplifying assumptions are as follows: (1) the deplanation of the cross section is uniform along the bar; (2) the cross sections behave as rigid in their own planes.

In the particular case of simple bending some solutions obtained in this way reduce to elementary solutions; in other cases, to those of the exact theory of elasticity, assuming a particular value of Poisson's ratio. Similarly, for the shear center a good agreement with the exact theory of elasticity is obtained; e.g., for a section in the form of a full semicircle the position of the shear center corresponds to the value $\nu = 0.25$. For an ellipse with semiaxes a and b, an approximate solution is obtained which, for small values of a/b, is in agreement with the exact solution (similar to the elementary theory), etc.

From author's summary

4898. Ellington, J. P., and McCallion, H., Moments and deflections of a simply-supported beam grillage, *Aero. Quart.* **8**, 4, 360–368, Nov. 1957.

Grillage dealt with is simplest possible with equidistant beams in both orthogonal directions, all with constant moment of inertia for their full length and not transmitting bending or torsional moments to each other. Loading is applied as concentrated loads at nodes only. In both directions bending moments at three consecutive nodes are expressed by means of deflections at same nodes according to Clapeyron's equation. Equilibrium is obtained by putting shearing forces at node expressed by means of bending moments equal to applied load. Solution is not very suitable for design, but may be used in certain cases as check of accuracy of usual approximate methods.

G. Vedeler, Norway

4899. Reynolds, C. E., Beams and slabs designed by the load-factor method, *Concr. constr. Engng.* **53**, 5, 181–194, May 1958.

4900. Saelman, B., A note on the optimum distribution of material in a beam for stiffness, *J. aero. Sci.* **25,** 4, p. 268 (Readers' Forum), Apr. 1958.

4901. Hatta, H., Analysis of the strain in bent and twisted thin rods by vectorial methods, *Bull. Fac. Engng., Yokohama nat. Univ* **5,** 55–61, Mar. 1956.

Author has investigated the strain in a rod having the shape of a space-curve. An elegant analysis is presented using vector methods. This approach, together with the form of presentation of the results, does yield a relatively simple concept of the nature of the quantities involved, as the author points out.

E. J. McBride, USA

4902. Demidov, S. P., An investigation of the stresses in a two-dimensional, curved beam of rectangular cross section in the conditions of plane spatial stress (in Russian), "Strength calculations in mechanical engineering," Moscow, Mashgiz, 1956, 28–62.

Plates, Disks, Shells, Membranes

(See also Revs. 4878, 4880, 4934, 4952, 4979)

4903. Truesdell, C., General solution for the stresses in a curved membrane, *Proc. nat. Acad. Sci. Wash.* **43,** 12, 1070–1072, Dec. 1957.

Author generalizes a result of L. Finzi to obtain the general solution to the Cauchy equations of equilibrium for any space in which covariant differentiation is defined and the conditions of compatibility are known. The result is applied to membranes regarded as Riemannian space of two dimensions. Known results for membranes of constant curvature and for membranes applicable upon a surface of revolution are confirmed.

C. T. West, USA

4904. Meier-Dornberg, K.-E., Experimental determination of the deflected surface of circular membranes under hydrostatic pressure (in German), *Ing.-Arch.* **26,** 93–95, Mar. 1958.

Tests were made with a circular membrane of "Hostaphan" in the vertical plane and loaded with hydrostatic pressure. Author considers the measured deflections an exact confirmation of the theory developed by Professor K. Karas in an earlier article [AMR **11** (1958), Rev. 812]. M. Holt, USA

4905. Andreeva, L. E., Calculation of the properties of corrugated membranes (in Russian), *Priborostroenie* no. 3, 11–17, 1956; *Ref. Zh. Mekh.*, no. 1, 1957, Rev. 857.

A solution is given for the problem of calculating the deflection of a membrane of any recurrent profile with an arbitrary depth of corrugation. The solution is based on the substitution of the corrugated membrane by a flat membrane of the same thickness, but possessing anisotropic properties in the radial and peripheral directions. Having determined the elastic coefficients of the anisotropic plate for the most frequently met with cases of corrugation, author introduces the characteristics equation of the membrane, obtained as the result of integration of the differential equations of the problem and application of the Bubnov-Galerkin method of finite deflections. Curves to assist the calculations are given. An example of a numerical calculation is investigated.

N. N. Babaev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—4906. Volmir, A. S., Theory of elastic circular plates (in Russian), Moscow, Izdat. Inost. Lit., 1954, 207 pp. 8.45 rubles.

In 1953 the Department of Mechanics of the Mathematics Institute of the Chinese Academy of Sciences conducted a conference in Peiping dealing with the theory of thin circular plates with large deflections. The proceedings of this conference were compiled by W. Z. Chien of that Academy in 1954 and the present book represents a translation and annotation into Russian of that work.

The book essentially presents six papers. The first, by W. Z. Chien, develops the basic theory of thin elastic circular plates with large deflections in the presence of axial symmetry. The von Karman equations are derived, the solution for a circular membrane due to Hencky is presented, the use of variational methods is discussed, and finally Foppl's approximation is given. The second paper, due to Hu Hai-Chang, discusses the contributions of Feodosev, Panov, and Alekseev to approximate solutions of circular plate problems, including a treatment of a corrugated plate. The nonlinear equations governing the equilibrium of shallow spherical shells subject to uniform normal load are derived and solved for several boundary conditions. The third paper, again by W. Z. Chien, discusses the application of perturbation methods to the solution of problems involving large deflections of circular plates. This technique was employed by Chien in 1947 to investigate the deflections of a clamped edge plate subject to uniform load. Asymptotic methods of solution are also discussed briefly.

The fourth paper, by K. Y. Yeh, treats circular plates having central holes. Solutions for various boundary conditions are obtained by a perturbation technique, using as a parameter the deflection of the plate at the edge of the hole. The fifth paper, due to Hu Hai-Chang, investigates the snapping or "durchschlag" of thin shallow spherical shells subject to various axisymmetric loadings. The sixth paper, by H. S. Lin, treats various nonlinear boundary-value problems of buckled circular plates.

The book concludes with a presentation of brief discussions presented at the conference by the afore-mentioned as well as several other investigators. Lastly, an appendix by Chien and Yeh treats additional boundary-value problems involving circular plates, with either uniform or centrally placed concentrated normal loadings. The book is well referenced and indicates a thorough knowledge of Western literature.

W. A. Nash, USA

4907. Gladwell, G. M. L., Some mixed boundary value problems in isotropic thin plate theory, *Quart. J. Mech. appl. Math.* **11,** 2, 159–171, May 1958.

The mixed boundary-value problems with which the paper deals are problems in which the plate is clamped along part of the boundary and is either free, or subject to specified bending moment and shear, along the remainder. Complex variable analysis, and especially the techniques evolved by Muskhelishvili, are used throughout. First the general boundary conditions for the problems are stated and reduced to a suitable form and then, using known results for plates with fully clamped boundaries, the boundary conditions are reduced to nonhomogeneous Hilbert problems—the kind of problem treated by Muskhelishvili. Special attention is given to the case of point loading in the interior of the plate, and to the case when part of the boundary is subject to constant bending moments and shears.

From author's summary by E. Steneroth, Sweden

4908. Bassali, W. A., and Nassif, M., Transverse bending of infinite and semi-infinite thin elastic plates, III, *Proc. Camb. phil. Soc.* **54,** 2, 288–299, Apr. 1958.

Within the restrictions of the classical plate theory, complex variable methods are used in this paper to develop an exact expression for the transverse displacement of an infinitely large isotropic plate having a free outer boundary and elastically re-

strained at an inner circular boundary, the plate being subjected to a general type of loading distributed over the area of a circle. The limiting case of a half-plane clamped along the straight edge and acted upon normally by the same loading is also considered.

From authors' summary by B. A. Boley, USA

4909. Bassali, W. A., Problems concerning the bending of isotropic thin elastic plates subject to various distributions of normal pressure, *Proc. Camb. phil. Soc.* **54,** 2, 265–287, Apr. 1958.

Within the limitations of the small-deflection plate theory, complex variable methods are used in this paper to obtain an exact solution for the problem of a thin circular plate supported at several interior or boundary points, and subjected to a normal loading spread over the area of an eccentric circle, the boundary of the plate being free. The load considered includes as a special case a linearly varying load over the circle and, as the radius of the loaded circle tends to zero, this load can be made to tend to a couple nucleus at its center. As limiting cases the procedure gives solutions appropriate to a circular plate, an infinitely large plate, and a half-plane having free boundaries and acted upon by any normal system of concentrated forces and concentrated couples in equilibrium. Formulas for the moments, shears and deflections relating to special examples are worked out in detail.

From author's summary by B. A. Boley, USA

4910. Hodge, P. G., Jr., and Sankaranarayanan, R., On finite expansion of a hole in a thin infinite plate, *Quart. appl. Math.* **16,** 1, 73–80, Apr. 1958.

A complete solution is given for the finite expansion of a circular hole from radius zero in a thin plate of initially uniform thickness under the following conditions: The material is assumed as rigid-plastic; it follows the yield condition of Tresca and the associated rule of flow; it hardens isotropically. The application of the solution for a hole expanded from a finite radius is also possible by discarding the part of the solution around the edge of the hole, which is not required. Diagrams show the distribution of stresses and thickness (after deformation) in comparison with another solution, which Alexander and Ford [*Proc. roy. Soc.* (A) **226,** 543–561, 1954] had given, assuming the yield condition of Mises. Although the stresses are in good agreement, there is some discrepancy between the two distributions of strain. Experiments alone can decide the real behavior of the material.

H. Neuber, Germany

4911. Borg, M. F., Maximum stress concentration factors caused by two equal circular holes in a plate subjected to uniform axial loading, *David W. Taylor Mod. Basin Rep.* 907, 13 pp., Sept. 1957.

Two specimens, designed to explore significant and insignificant interaction of the effects of two circular holes, were tested under uniform axial compression. The experimental data verify the maximum stress concentration factors obtained theoretically by Ling. The verified theoretical values are presented both in tabular form and in a chart suitable for engineering purposes.

From author's summary

4912. Zabludovskii, V. M., Extension of an infinite plate, weakened by two circular openings (in Russian), Byul nauk. stud. konferentsii, 1954 roku. Chast. 2, L'viv, Vid-voun-tu, 106–108, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2148.

The method of N. I. Muskhelishvili is used to determine the stressed condition in an extensible infinite plate, weakened by two round openings; the region of the plate is reflected on a round ring of functions of the form $z = \alpha(\zeta + b)/(\zeta - b)$. Results are given of the calculations of the ring stresses for two points on the edge of the smaller of the two openings, when the boundary of the plate is free from external forces (for $r_2 = \frac{1}{2}r_1$, $O_1O_2 = 5r_2$, where r_1 and r_2 are the radii of the openings, O_1O_2 are the distances between their centers).

N. S. Chausov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4913. Taraporewalla, K. J., Design of grid and diagrid systems on the analogy of design of plates, *Struct. Engr.* **36,** 4, 121–128, Apr. 1958.

The principal value of the paper is that it represents an application of the orthotropic plate analogy in the design of a system of girders. Beyond that there are some serious defects. Author assumes that the two orthogonal systems of beams act independently of each other without giving any justification. As a consequence he makes the convenient assumption that the Poisson-type constants are zero. Then he writes down the solution for the differential equation of equilibrium, assuming simple support around the boundary of a rectangular plate in which the principal axes of stiffness are parallel respectively to the sides of the plate. Apparently using the identical differential equation and boundary conditions, he computes bending moments for an orthogonal system of girders which make angles of 45° with the sides of the rectangular plate. Reviewer considers this to be a serious error. He also questions author's method of computing the effective elastic compliances.

W. H. Hoppmann, II, USA

4914. Lee, J. A. N., Stiffening effects of edge beams on a right slab bridge, *Engineering* **185,** 4807, 539–542, Apr. 1958.

Paper deals with rectangular slabs simply supported along two opposite edges and stiffened by edge beams along two opposite, otherwise free, edges. Shear reactions and bending moment reactions along edge beams are expanded in Fourier series whose coefficients are obtained by equalizing deflections and slopes for slab and edge beams. Results are compared to some experiments, with satisfactory agreement.

W. T. Koiter, Holland

4915. Galimov, K. Z., Variational methods of solving problems of the theory of plates and shells (in Russian), *Ucb. zap. Kazansk. in-ta* **116,** 1, 36–40, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3403.

A variational formula is given for the equilibrium condition of an elastic envelope in the presence of finite deformations, containing nine functional arguments: the components of the displacement vector v_i, v, and the symmetrical tensors of the shear stresses S^{ij} and moments M^{ij}.

It is assumed that the components of the vector of the external forces X^j, X admit of potential f, such that

$$X^j = \partial f/\partial v_j; \quad X^j = \partial f/\partial v$$

The steady-state conditions are represented by three equations of equilibrium and six relationships between the deformation tensors p_{ij}, q_{ij} (expressed in the variational formula by v_i, v), and the tensors S^{ij}, M^{ij}. The latter relationships coincide in form with the elasticity relationships. The variations of the functional arguments on the contour are unrestricted.

In the particular case of a flat shell, the boundary conditions for the stress function are formulated.

N. A. Alumyae

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4916. Liamshev, L. M., Sound diffraction by a thin bounded elastic cylindrical shell, *Soviet Phys. "Doklady"* **2,** 4, 332–335, May, 1958. [Translation of *Doklady Akad. Nauk SSSR* (N.S.) **115,** 1–6, 271–273, July–Aug., 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

Analysis of title problem is summarized for incidence of plane wave from any direction [normal incidence having been treated

earlier by M. Junger, AMR **5** (1952), Rev. 3574; **7** (1954), Rev. 2761]. No quantitative results are presented.

J. W. Miles, USA

4917. Clark, R. A., Asymptotic solutions of toroidal shell problems, *Quart. appl. Math.* **16,** 1, 47–60, Apr. 1958.

Method of asymptotic integration developed by E. Reissner and author is refined, and solutions previously obtained for problems of bending of curved tube and of a toroidal expansion joint subject to an axial force are generalized and extended. Results are compared to those obtained by L. Beskin. For large values of a certain parameter, agreement is good.

A. P. Boresi, USA

4918. Dulácska, E., Elliptic paraboloid shell (in Hungarian), *Mélyépitéstudományi Szemle* **7,** 11/12, 382–385, Nov./Dec. 1957.

Paper presents membrane analysis of a shell roof over a rectangular area, subjected to distributed loading of constant intensity in the horizontal plane (snow load). Method of solution is an extension of the one introduced by P. Csonka. It consists of assuming for the membrane stress function a polynomial expression, the coefficients of which are adjusted by the method of least squares, so as to give the best approximation for the prescribed loading condition. For illustration a numerical example is chosen which was analyzed previously by I. Menyhárd, using an arctangent function. There is good agreement in all stress-resultant values except at the corners, where this latter approach obviates singularities in shear. M. Hetényi, USA

4919. Schleeh, W., Numerical check of the design of bending resistant cylindrical shells (in German), *Beton u. Stahlbeton.* **52,** 11, 277–279, Nov. 1957.

Author presents a method of checking the numerical results in the design of circular cylindrical shells. The method consists of checking that the six equations of equilibrium are satisfied for the shell, or part of the shell, as a whole. Author gives a table where the results of an example are gathered very nicely. He also shows the degree of accuracy to which the equations of equilibrium are satisfied. The method has been used by Dr. O. Jenssen, N.T.H., to check another example, and he found that in his case the method did not give any check on the bending moments in the shell. From the author's own example it may be seen that an error in the difference of the bending moments $[M_{\varphi(1)} - M_{\varphi(2)}]$ of more than 100% is not detected by the author's method of checking. L. N. Persen, Norway

4920. Kurdin, N. S., The symmetrical deformation of an orthotropic shell of parabolic profile (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **23,** 94–99, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3404.

The deformation of an isotropic shell of parabolic profile, the edges of which are borne on sliding supports, is investigated for the case of symmetrical loading.

The problem is solved by the method of the small parameter. Two loading cases are considered: (1) The shell is stretched along the edges by uniformly distributed forces; (2) the shell is subjected to the action of a uniform, external pressure. Expressions are then derived for the displacements, forces and moments, in the first approximation. Curves are given for the development of the forces and moments along the length of the shell, when composed of three different materials, and are compared with the results obtained by the present abstractor [*Prikl. Mat. Mekh.* **8,** no. 4, 1949] for the case when the edges of the shell are unconstrained. These curves show the influence of anistropy of the material on the stress distribution and distribution of the moments along the shell. E. F. Burmistrov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4921. Nazarov, A. A., The method of successive approximations in the theory of flat shells (in Russian), *Uch. zap. Saratovsk. in-ta* **52,** 33–39, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3406.

A method of successive approximation is described for the solution of linear problems in the theory of flat shells. In the first variant, the stress function and the flexure function are applied in the form of exponential expansions of the small parameters, which are assumed to correspond to the parameters of curvature of the shell. The problem is reduced to the solution of a system of recurrent, differential equations, it being necessary at each stage of the approximation to solve the problem of the plane stress condition, and the problem of the bending of the plate on which the shell is projected in plan. A formulation is given of the problems of the theory of flat shells, in terms of the complex variables. It is noted that the method of small parameters is of practical value only for shells with a small amount of rise.

In the second variant, the small parameter is represented by the thickness of the shell, while the stress and flexure functions are introduced in the form of expansions of this parameter by its exponents. Numerical examples are discussed. No bibliographical references are given. M. S. Kornishin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4922. Bukharinov, G. N., The axially-symmetrical deformation of a cylinder of finite length (in Russian), *Vestn. Leningr. un-ta* no. 7, 77–86, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3346.

A solution is presented for the problem of the axially-symmetrical deformation of a circular cylinder of finite length. The boundary conditions at the ends of the cylinder are satisfied rigorously; on the envelope of the cylinder, approximately.

V. L. Biderman

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4923. Burmistrov, E. F., The problem of the deformation of a shell in the form of an elliptical cylinder approaching the circular form (in Russian), *Uch. zap. Saratovsk. un-ta* **22,** 93–101, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3407.

A solution is provided for the problem of the deformation of an orthotropic shell in the form of an elliptical cylinder approaching the circular form, under the action of a load uniformly distributed over the lateral surface.

The shell is assumed to be freely supported on the end sections. The solution is obtained by the method of small parameters, and is developed to calculation formulas incorporating the small parameter in terms of the first order.

The calculation formulas are illustrated by two numerical examples, confirming the very satisfactory convergence of the series determining the normal displacement of the envelope.

B. I. Slepov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Buckling Problems

(See Rev. 4953)

4924. Schleicher, F., The Shanley effect, *Bauingenieur* **32,** 12, 449–458, Dec. 1957.

Essentially, author discusses in detail the possible equilibrium configurations between the tangent-modulus ("Engesser-Shanley") load and the double-modulus ("Engesser-Karman") load to which Karman called attention in his discussion of F. R. Shanley's "Inelastic column theory" [AMR **1** (1948), Rev. 72].

Author's discussion is based largely on the model suggested by E. L. Ryder [AMR 1 (1948), Rev. 72], namely, a column consisting of two rigid portions connected end to end by two short parallel flanges perpendicular to the plane of bending.

W. R. Osgood, USA

4925. Burgermeister, G., and Steup, H., Iterative solution of problems involving bending deformations (in German), *Stahlbau* **26,** 7, 183–187, July 1957.

Authors investigate problem of slender frameworks where buckling-type deformations are important, i.e., combined axial load and bending of a member. Method of solution is illustrated by application to a simple bent. G. W. Housner, USA

4926. Kloppel, K., and Goder, W., Calculation by successive approximation of bending moments according to second-order theory (in German), *Stahlbau* **26,** 7, 188–191, July 1957.

Paper investigates the bending moment in frameworks where the axial forces are sufficiently large to produce significant bending moments. Method of solution is illustrated by application to simple frameworks. G. W. Housner, USA

4927. Shanshiashvili, A. M., Calculations for steel columns and beams with partially closed contour (in Russian), *Trudī Gruz. politekhn. in-ta* no. 4, 43–56, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2332.

The problem was examined of the stability of a thin-walled bar with an open rigid profile, with one axis of symmetry, partially closed with strips of metal, when compressed by a central longitudinal force. The problem is examined accurately and approximately. The accurate solution issues from the system of linear homogeneous differential equations with V. Z. Vlasov's constant coefficients of spatial stability of a thin-walled bar in the displacements. As a result of solving the system of equations, formulae were obtained for determining the bi-moment, the torsion and deflection moments and the transverse force at the ends of the bar in relation to the end displacements. An example is given of the use of these formulae for calculating the critical force on a channel bar, closed by hinges, of torsion and deflection at the ends. The bar is strengthened by two strips on the ends. The approximate solution is obtained by means of Galerkin's variation method. The approximate function for the angle of torsion of the bar is assumed to be analogous to the function of the bending of the beam when it is deflected by its transverse load, distributed according to the sinusoidal principle, during which it is (also) assumed to have elastic fastenings in the sections corresponding to the places of distribution of the strips in the given bar. An examination is made of an example of the approximate calculation for a channel bar with four strips. The problem converges with the calculation for a bar with open contour, with adjustments in the determination of the sector rigidity and the center of deflection. The example shows a large increase in the critical force when strips are applied. Author recommends the strengthening also of thin-walled beams with strips, if the beams are working under deflection stresses. V. A. Mar'in

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4928. Krolevetz, M. S., The modulus of elasticity of steel wire ropes (in Russian), "Research on problems of strength and resistance," Kiev, Akad. Nauk USSR, 1956, 243–253; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3730.

Determination of the elasticity modulus by static tensile tests gives values which are too low, because of the relaxation phenomena occurring under slowly-applied load. To calculate the corresponding dynamic modulus, measurements were made of the frequency of longitudinal vibration of a wire rope 20 meters long with a weight suspended at one end. Wire strain gages were cemented on the rope, the indications whereof were recorded by a loop oscillograph. Knowing the frequency, it was possible to calculate the rate of propagation of the elastic wave and the corresponding modulus, the value of which is in such case independent of the applied stress and some 10–20% greater than the static modulus, increasing in individual cases to 30%.

In the case of absence of experimental (test) data, author suggests determination of the E-modulus by the formula:

$$E = K\,\frac{q}{S} - 10^4 \text{ kg/cm}^2$$

(q weight per running metre (kg/m), S cross-sectional area of the metal part of the rope (mm^2); K an empirical coeffiçient varying between 1.25 and 2.10, depending on the type of rope). Author's statement that energy dissipation in irreversible processes is greater under dynamic than under static load is incorrect.

N. N. Davidenkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4929. Thiry, R., and Dantu, P., General study of an experimental method for the direct determination of deformations in a solid (in French), 9th Congrès intern. Mecan. appl., Univ. Bruxelles, 1957; **8,** 490–499.

4930. Mesmer, G., Stresses in pin-loaded eye-shaped bars (in English), 9th Congrès intern. Mecan. appl. Univ. Bruxelles 1957; **8,** 352–356.

The problem of the stress distribution in eye-shaped bars, loaded by a pin, has often been discussed. Some of the essential contributions are compiled in the bibliography.

From author's summary

4931. Bennett, J. D., Design of eccentrically-loaded columns by the load-factor method. Part 4, *Concr. constr. Engng.* **53,** 5, 201–211, May, 1958.

4932. Bartlett, R. J., Circular reinforced concrete columns, *Concr. constr. Engng.* **53,** 4, 149–156, Apr. 1958.

4933. Bennett, J. D., Design of eccentrically-loaded columns by the load-factor method. Part 5, *Concr. constr. Engng.* **53,** 3, 119–128, Mar. 1958.

4934. Kaul, R. K., and Tewari, S. G., On the bounds of the critical load of a clamped plate in compression, *J. aero. Soc. India* **9,** 4, 56–59, Apr. 1957.

Problem dealt with is governed by differential equation

$$R \equiv \Delta^4_w + \lambda\,\Delta^2_w = 0$$

Based on method given by Temple on accuracy of Rayleigh's principle, authors calculate maximum error in Rayleigh's approximation λ_1 to first eigenvalue by assumed mode w according to formula

$$\epsilon_v^2 = \int_0^1\int_0^1 v\,R\,dx\,dy \quad \int_0^1\int_0^1 w\,\Delta^4 w\,dx\,dy$$

where v is solution of $\Delta^4_w = R$. Main part of paper concerns this solution, which is obtained by assuming v to be product of function of x only and function of y only. Then Rayleigh's approximation λ_2 to next symmetrical mode is calculated. By means of λ_1, λ_2 and ϵ_v^2, lower bound to first eigenvalue is obtained by means of formula given by Temple. This lower bound gives better approximation than Rayleigh's upper bound for same tentative mode w.

Nomenclature for nondimensional versus dimensional eigenvalues is somewhat careless. G. Vedeler, Norway

4935. Johnson, A. E., Jr., Charts relating the compressive and shear buckling stresses of longitudinally supported plates to the effective deflectional stiffness of the supports, *NACA TN* 4188, 17 pp. + 1 table + 8 figs., Feb. 1958.

Paper investigates buckling of long rectangular plates subjected to combined shear and compressive end loads. The edges of the plate are assumed simply supported and the plate stiffened along one or two longitudinal lines by flexural springs representing the restraint of stringers, webs, etc. A number of clear charts illustrate analytical results by Rayleigh-Ritz technique.

J. H. Argyris, England

Joints and Joining Methods

4936. Gent, A. R., The torsional stiffness of fabricated members, *Struct. Engr.* **36,** 5, 153–164, May 1958.

Paper presents an approximate theory for twisting of a pair of narrow plates tack-welded face-to-face at intervals along their long edges or along lines parallel to their long edges, the welds being located at the same distances along the two lines. In regions of tack-welds the two plates are assumed to form a solid section. Between welds torsion is assumed to be resisted by a combination of twisting moments in the individual plates and couple formed by transverse shears in plates, the plates being fully restrained against warping at the welds. Experimental results for pairs of plates forming a simple member and for pairs of plates forming the flanges of built-up I-sections show that theory gives good prediction of torsional stiffness. Experiments were also made with riveted plates and show that similar theory may be applied if modifications are made as suggested by author for rivet slip and rivet bending. Reviewer notes that transverse shear is taken as flexural rigidity times third derivative of transverse displacement in formulating differential equation, but is taken as shear rigidity times shear strain in writing boundary conditions. This partial cognizance of shear deformation may account for excellent agreement between experimental results and suggested theory in cases where welds are so closely spaced that shear deformations might be expected to make the major contribution to angular deflections. J. E. Goldberg, USA

4937. Farkas, J., Calculation of eccentrically loaded riveted or bolted joints in case of irregular arrangement (in Hungarian), *Mélyépitéstudományi Szemle* **7,** 11/12, 369–371, Nov./Dec. 1957.

Author assumes elastic rivet resistance, proportional to displacement. Deformation in plates is disregarded. Method is based on determination of center of rotation of joint, instead of the customary center of gravity of rivet cross sections. Advantage is immediate location of most severely loaded rivet. This is illustrated by numerical examples. Procedure is equally applicable if rivets are not all of the same size. M. Hetenyi, USA

4938. Dimensional standardization of semi-tubular rivets, *Prod. Engng.* (Design Digest Issue) **28,** 15, G2–G3, Oct. 1957.

4939. Koopman, K. H., Elements of joint design for welding, *Welding J.* **37,** 6, 579–588, June 1958.

Structures

(See also Revs. 4900, 4905, 4914, 4918, 4920, 4925, 4926 4931, 4932, 4936, 4994, 4996, 4997, 5000, 5016, 5064, 5148, 5217, 5219, 5232, 5281)

4940. Csonka, P., Stiffness characteristics of rigid Warren girders, *Acta Techn. Hung. Budapest* **20,** 1/2, 103–118, 1958.

Paper presents engineering formulas for uncoupled average rigidities of uniform, rigid-jointed Warren trusses under axial load, pure bending in plane of truss, pure bending out of plane, and pure torsion. Problems are closely related to secondary stress analysis of trusses and three-dimensional frame analysis, which now are well understood by engineers. End effects and warping restraints are not considered. Paper is one of a series by author in which equivalent rigidities of various forms of uniform, rigid-jointed, parallel-chord trusses are calculated.

J. E. Goldberg, USA

4941. Csonka, P., Stiffness characteristics of Vierendeel girders with parallel chords, *Acta Techn. Hung. Budapest* **20,** 3/4, 251–260, 1958.

Paper presents engineering formulas for uncoupled average rigidities of uniform Vierendeel girders under axial load, pure bending in plane of girder, pure bending out of plane, and pure torsion without internal or external warping restraint. Joints are treated as rigid, but dimensions of joints are taken into account only in the first three cases. End effects are not considered and, therefore, formulas may be valid only for regions remote from ends. Author asserts that formulas have application in analysis of structures in which Vierendeel girder forms an element, since formulas permit replacement of girder by equivalent bar.

J. E. Goldberg, USA

4942. Freda, D., and Greco, C., An extension of the Kani method to the calculation of frames with discontinuous beams (in Italian), *G. Gen. civ.* **96,** 1, 73–77, Jan. 1958.

Authors extend the Kani method [see G. Kani "Analysis of multistory frames," Ungar Publishing Co., New York, 1957; English translation from the German] to building frames in which some of the beams may be discontinuous, i.e., missing entirely in some bays. Known concept of auxiliary ties is utilized in the procedure, which is illustrated with a numerical example.

Reviewer believes the procedure, as well as the original Kani method, compares favorably with other iterative schemes of calculation. It should appeal to those structural engineers who prefer slide rule to digital computer calculations.

S. J. Medwadowski, USA

4943. Caironi, M., Observations on successive approximation procedures in the methods of powers (in Italian), *Ingegnere* **31,** 5, 410–420, May 1957.

Iteration procedure in matrix notation. A transformation matrix is introduced and interpreted in terms of influence coefficients for forces and displacements in such a way as to reestablish compatibility in redundant structures which are treated by a determinate substructure. The result is a procedure for solving symmetric equations by graphical and tabular methods, being a generalization of the method of Wright for solving systems of equations by successive approximations.

From author's summary by B. Langefors, Sweden

4944. Slavin, M. Ya., The graphical analysis of statically indeterminate systems (in Russian), *Nauch. tr. Leningr. inzh.-stroit. in-ta* no. 23, 84–101, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3578.

A graphical method is described for the calculation of statically indeterminate systems, which is based on utilizing the properties of the focal points at the corners. This method is also one of the graphical means of solving systems of trinomial, canonical equations, to which a number of problems of structural mechanics can be reduced.

The essence of the method consists in graphically determining the angles of rotation of the joints of a frame, knowing which, the

curves of the forces involved can be constructed by known methods.

Applying the group unknowns of the method of displacements, author obtains relationships enabling also the analytical calculation of frame systems not containing closed contours.

P. B. Antonevich

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4945. Roik, K., Stability of supports in the plastic region (in German), *Stahlbau* **26**, 7, 202–203, July 1957.

4946. Jones, R., The effect of frequency on the dynamic modulus and damping coefficient of concrete, *Mag. Concr. Res.* **9**, 26, 69–72, Aug. 1957.

Experiments have been made to determine the resonant frequencies of concrete beams in flexural, longitudinal, and torsional modes of vibration at the fundamental and higher harmonics. The results were used to study the effect of frequency on the dynamic Young's modulus and dynamic shear modulus.

It was found that for wet concrete there was no appreciable difference in the dynamic Young's modulus determined from the flexural and longitudinal modes of vibration. The modulus changed by less than 3% as the frequency increased from 70 to 10,000 cps. The dynamic shear modulus also showed no appreciable change with frequency over the range of 700–10,000 cps.

When the concrete beam was allowed to dry, Young's modulus calculated from the flexural vibrations was lower than that calculated from longitudinal vibrations. The discrepancy is attributed to moisture differences within the concrete beam. It is suggested that surface drying of concrete beams might account for the differences of modulus previously observed in flexure between beams of different size made of nominally the same concrete.

The damping coefficient in the moist concrete did not change appreciably with frequency and, at a particular age, was approximately the same for all three modes of vibration. It is concluded that damping of the vibrations arises chiefly at the interfacial boundaries within the concrete.

From author's summary

4947. Ulitsky, I. I., The rigidity of ferroconcrete structures under continuing load in bending (in Russian), "New developments in structural engineering," no. 7, Kiev, State Publishing Office for Building Construction and Architecture SSSR, 1955, 191–223; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3641.

On the basis of the familiar formula for the creep of ferroconcrete, a mean conditional modulus of elasticity on a time-variable scale is introduced for the reinforcement of a cracked concrete structure, stressed in tension.

Author criticizes the methods of determining rigidity and flexure of ferroconcrete beams which were set up by the Technical Rules of the N and TU, Nos. 123-55, and which do not take account of the physical nature of continuing deformation (creep). New calculation formulas are suggested.

The problem of ferroconcrete beam of unsymmetrical cross section is examined. M. A. Zadoyan

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4948. Base, G. D., Some tests on the effect of time on transmission length in pretensioned concrete, *Mag. Concr. Res.* **9**, 26, 73–82, Aug. 1957.

4949. Bolcskei, E., High-tensile steel cable tie-rods, Extracts from Scientific Works of the Chair no. 2 of Bridge Construction (Epitoipari es Kozlekedesi Muszaki Egyetem. Tudomanyos Kozlemenyei), Budapest, 1957, 29–40.

4950. Harpur, N. F., Fail-safe structural design, *J. roy. aero. Soc.* **62**, 569, 363–376, May 1958.

4951. Falk, S., Calculation of closed frames according to the reduction method (in German), *Ing.-Arch.* **26**, 96–109, Mar. 1958.

The present article is a continuation of the author's previous paper on "reduction" method [AMR **11** (1958), Rev. 3917]. This method of analysis has been used by Prof. Argyris in England and Denke et al in this country under the name of "matrix methods." The author gives formulas in matrices which can be efficiently applied by computers. The superiority of this method over the conventional elimination method is illustrated by two numerical examples. M. Maletz, USA

4952. Hemp, W. S., Notes on the problem of the optimum design of structures, *Coll. Aero. Cranfield Note* 73, 8 pp., Jan. 1958.

The urgent need for a systematic approach to the problems of the optimum design of structures is stressed and ideal formulations of these problems are considered. Differential equations and a variational principle are derived for the case of plates loaded in their own planes; these can form the basis for approximate solutions, in the form of optimum distributions of plate thickness and the corresponding stress distributions which are required to equilibrate given systems of external loads.

From author's summary by B. E. Gatewood, USA

4953. Salion, V. E., The dynamic stability of a circular arch under the action of periodic moments (nonplanar deformation) (in Russian), "Investigations on problems of stability and strength," Kiev, Akad. Nauk SSSR, 1956, 123–127; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3450.

The loss of stability is investigated of a circular arch of narrow, rectangular cross section, experiencing simple bending by two periodic moments, $M = M_0 \cos \omega t$. A Kirchhoff differential equation of motion is constructed for the arch in the presence of three-dimensional deformation, which after transformation is brought to the form of a Hill equation. Approximate values are given for the frequencies ω, ω', bounding the region of instability of the arch.

A. A. Pikovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4954. Liptak, L., On the reaction between the bridge arch and the stiffening girder (in German), *Öst. Bauzeitschr.* **12**, 9, 194–207, Sept. 1957.

Paper is devoted to the study of the bow-string bridge, and attempts to improve the analysis of the distribution of live load between the two arches and the floor by taking into account the three-dimensional distribution of forces.

The live loading is separated into components symmetrical and antisymmetrical with respect to the longitudinal axis of the floor. The study of the bridge action under the symmetrical component is conventional, except that additional effects due to the action of the load between the individual hangers and the rigid connection of the floor with the arches at their ends are discussed in detail.

The analysis of the antisymmetrical loading seems to be new. Taking into account the torsional and warping rigidities of the floor, author establishes a linear differential equation of the fourth order for the vertical deflection of the arch. A numerical example is fully solved and the main influence lines necessary for the design are given. C. Massonnet, Belgium

4955. Dronov, A. A., Prestressed reinforced concrete bridges (in Russian), *Trudi Kievsk. avtomob.-dor. in-ta* no. 2, 71–101, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3650.

Author discusses the construction of a bridge span composed of steel beams with attached ferroconcrete slab. The method of

erecting a single-span bridge contemplates the erection of the steel girders on a temporary intermediate pier having a higher datum level than that of the permanent abutments. The slab is concreted at this stage. The weight of the slab and of the beams themselves causes the latter to bend convexly upwards. Upon setting of the concrete the temporary pier is removed and the span assumes its designed position, at the same time experiencing a preliminary or initial stress. The method of calculation of such a structure for all forms of applied loads (continuous and intermittent loading, temperature variations), with allowance for the increase of strength of the concrete by ageing, and the influences of creep and settling are described. The relationships characterizing the creep of concrete, quoted in particular in the book of I. I. Ulitsky ["The calculation of concrete and ferroconcrete, arch and combined bridges," Gostekhizdat USSR, 1950], are utilized. An example of such a calculation is given. A. P. Filin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4956. Kirsanov, N. N., Calculation of single-span suspension bridges for sag (in Russian), *Sb. tr. Mosk. inzh.-stroit. in-ta* no. 10, 48–64, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3658.

A method of calculation is described for single-span suspension bridges with a rigid stiffening truss of constant cross section, with consideration of the displacements of the suspension cables and the stiffening truss. The calculation formulas for the flexures, angles of rotation, bending moments and side forces have been obtained by solution of the known differential equation for suspension bridges by the method of initial parameters. To facilitate solution, tables are given for the functions entering into the corresponding expressions. Two numerical examples are given. V. V. Novitskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4957. Platthy, P., Calculation and cover-plate design of bent asymmetric steel girders (in Hungarian), *Mélyépitéstudományi Szemle* **7**, 11/12, 372–374, Nov./Dec. 1957.

Graphical construction is proposed for determination of cover-plate arrangements in built-up girders. This avoids need for calculating moments of inertia of variable asymmetric sections.

M. Hetenyi, USA

4958. Zee, C.-H., Pore pressure in concrete dams, *Proc. Amer. Soc. civ. Engrs.* **84,** PO 2 (*J. Power Div.*), Pap. 1597, 12 pp., Apr. 1958.

A detailed discussion on the mechanics of uplift force acting within a concrete body is presented first by conceiving the concrete as a "space frame" structural body; thus the idea of the effective uplift area is explained. Furthermore, as water percolates through the "space frame" structural body, the seepage force occurs. The resultant of uplift and seepage forces is the pore pressure force, which may be deduced from the potential theory on flow through a pervious medium. Following this idea, the water dammed up by a concrete dam does not act entirely on the upstream face of the dam, it acts successively within the dam; accordingly the stresses within the dam are changed. Applying the conception of seepage face height in well hydraulics, the intensity of pore pressure at the drainage system near the upstream face of the dam as well as the most effective spacing of vertical drains can be determined in laboratory by means of electrical analogy or other comparable analysis.

From author's summary

4959. Hiltscher, R., and Pant, B., The tensile force near cutouts in uniaxial compression fields (in German), *Bauingenieur* **32,** 12, 470–474, Dec. 1957.

The tensile stress distribution near rectangular and elliptical cutouts in infinite plates is investigated; the axes of the cutouts are parallel to the uniaxial compressions applied. The resultants of these tensile stresses along an axis of symmetry between the edge of the cutout and the first change of sign of stress are determined, photoelastically for the rectangles and analytically for the ellipses. From a limited height-to-width ratio range investigated (five values ranging from 0.5 to 2 for rectangles, four values, namely 0, 0.5, 1 and 2 for ellipses) the results are extrapolated and generalized to other shapes. However, reviewer considers that the extrapolation for the rectangular sections in unwarranted; for very large height-to-width ratios the results for rectangles and ellipses should coincide—just as the authors found for very low ratios. The generalizations given in the paper are equally unsupported and likely to be incorrect for similar reasons. As the problem is of considerable practical importance in connection with stresses around galleries, etc., in dams, further investigations are warranted. G. Sved, Australia

4960. Gallotly, G. D., and Chilton, E. G., Design of prestressed cylinders with nonmetallic linings, *Indust. Engng. Chem.* **50,** 8, 65A-68A, Aug. 1958.

Vessels for highly corrosive reactions at elevated temperatures and pressures have been built with steel shells and nonmetallic linings. A design method will determine required wall thickness and prestress so that the liner does not crack or separate from the shell during operation. From authors' summary

4961. Ghali, A., Analysis of cylindrical tanks with flat bases by moment distribution methods, *Struct. Engr.* **36,** 5, 165–176, May 1958.

The moment distribution method is used to find the moments and the ring tension in the walls and the bases of the following two types of cylindrical tank: (a) Cylindrical tank on a rigid flat foundation; (b) Cylindrical tank with flat base supported on a cylindrical shaft of smaller diameter.

For the first type, a trial-and-error method is used to determine the width of the ring-shaped part of the base which will lift up from the foundation surface. In the second type, the variation of the thickness in the overhanging part of the base is taken into account. Graphs are presented in the appendix to facilitate the solution.

The design of each type is illustrated by a numerical example.

From author's summary

4962. Miller, D. R., and Cooper, W. E., Safeguard aspects of reactor vessel design, *Welding J.* **37,** 1, 22s–26s, Jan. 1958.

The problem of design of power-reactor vessels for safety and durability requires careful application of existing industrial experience and engineering fundamentals to assure adequate consideration of the new problems which arise. Internal heat generation in structural materials, radiation-induced changes in mechanical properties, thermal shock and strain cycling, and coolant-dissociation effects on corrosion and embrittlement all present problems which require close attention. The hazards of mechanical failure and the cost and difficulty of repair place a high value on safety and reliability and justify comprehensive structural-design criteria and evaluation coupled with close control of material and fabrication quality.

An uncommon problem associated with the pressure-vessel design is analysis of the consequences of conceivable accidents due to reactor runaway, or in some cases due to a nondetonating chemical reaction. In some cases a pressure-tight building is provided to prevent spread of radioactivity. The problem of penetration of the enclosure building by missiles from the pressure vessel then requires careful evaluation.

From authors' summary

4963. Widmayer, E., Jr., and Schwab, R. H., Structural and impact loads for the flexible airplane during water landings, *J. aero. Sci.* **25,** 3, 161–170, Mar. 1958.

In the computation of loads on elastic seaplanes during landing, it has usually been assumed that the hydrodynamic pressures and the flexible airplane response are uncoupled. The present paper gives a method of calculation which takes account of this coupling. The method is compared in the paper with the results of an experimental program in which both the hull bottom loads and the acceleration response of the Martin M-270 airplane were measured. Calculations are presented for both a rigid and a flexible airplane. The comparison between theoretical and experimental response curves is generally good, both in trend and in magnitude.

R. L. Bisplinghoff, USA

4964. Benthem, J. P., The effect of airplane structural flexibility on landing gear loads, *Nat. LuchtLab. Amsterdam Rap.* S. 478, 20 pp. + Append. + tables + figs., Oct. 1956.

Method is developed for solving simultaneously the nonlinear differential equations governing landing-gear behavior and the linear differential equations for the elastic deformation of the rest of the aircraft. Velocity-squared damping with an air-pressure preload is assumed for the landing-gear strut, and spin-up and spring-back loads are accounted for. Remainder of aircraft is treated by normal mode method. Calculations are made for an example realistic four-engine aircraft. Results show effects of aircraft flexibility on gear loads of about 15%.

J. M. Hedgepeth, USA

4965. Legg, K. L. C., and Stevens, G., Temperature distributions in aircraft structures and the influence of mechanical and physical material properties, *J. roy. aero. Soc.* **62,** 567, 174–186, Mar. 1958.

This is a general discussion of thermal effects in aircraft due to aerodynamic heating, engine installation and auxiliary systems. Numerical methods of analysis using digital and analog computers are sketched. Effects of mechanical and physical properties of conventional materials are given. A dimensional parameter named "thermal stress efficiency" is defined as a grading of structure material. Reviewer finds the name and the insertion of density in the denominator "to account for the weight consciousness of the aircraft designer" rather ungrounded. There are a number of examples showing the types of problems arising, with a brief indication of methods of attack.

L. S. Dzung, Switzerland

Rheology (Plastic, Viscoplastic Flow)

(See also Rev. 5216)

4966. Hill, R., A general theory of uniqueness and stability in elastic-plastic solids, *J. Mech. Phys. Solids* **6,** 3, 236–249, May 1958.

Author determines sufficient conditions for uniqueness of solutions for mixed stress and velocity boundary-value problems for a class of incremental-type plasticity theories, allowing for finite deformations and anisotropy, but neglecting inertia. He proposes a stability criterion which is unusual in that a non-unique solution may be stable.

Several subtle points are left to the reader to unravel. One is to determine whether Eq. [21] really follows from Eq. [20] when author's E depends on "strain history," which presumably means that it is a functional of velocity gradients.

J. L. Ericksen, USA

4967. Gaydon, F. A., and Nuttall, H., On the combined bending and twisting of beams of various sections, *J. Mech. Phys. Solids* **6,** 1, 17–26, 1957.

Using the inequalities of plastic limit analysis, authors derived interaction curves for combined bending and twisting of ideally plastic-rigid and nonhardening cylinders with rectangular, I, and box sections. The method used is applicable to any cross section having one axis of symmetry, by introducing a warping function into the assumed velocity mode. The problem is an extension of Hill and Siedel [AMR **7,** (1954), Rev. 104].

M. L. Pei, USA

4968. Hult, J. A. H., Elastic-plastic torsion of sharply notched bars, *J. Mech. Phys. Solids* **6,** 1, 79–82, 1957.

Torsion of a bar with a sharp longitudinal notch produces plastic yielding at the tip of the notch for any magnitude of the applied torque, however small. It is shown that the shape of the region of incipient plastic yielding can be found for any shape of the cross section, provided the solution of the corresponding elastic problem is known. The elastic stress field near the tip of a sharp notch in pure shear is found to be similar to the elastic stress field near a similar longitudinal notch in torsion. Since the shape of the plastic region produced at the notch in pure shear is known, the corresponding region in the torsion case can be derived by analogy.

From author's summary by E. G. Allen, USA

4969. Bland, D. R., The two measures of work-hardening (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **8,** 45–50.

A plastic solid with a homogeneous polynomial yield function is considered. It has often been assumed that the amount of hardening depends only on the total plastic work per unit volume or on a certain scalar measure of the total distortion (the so-called equivalent strain). Author shows that, when the plastic potential is the same polynomial, these two work-hardening hypotheses are only equivalent on parts of the yield surface where the polynomial is linear or quadratic in the principal stresses (in particular, the Tresca and Mises criteria). They are not equivalent at singular points (vertices) of the surface.

R. Hill, England

4970. Iskritskii, D. E., and Val'ter, L. L., Computation for the strength of the end connecting link of an anchor chain in an elastic and plastic state (in Russian), *Trudi Leningr. Korablestroit. in-ta* **16,** 60–75, 1955; *Ref. Zh. Mekh.* 1957, Rev. 2447.

An investigation is made of the end connecting link of a chain fitted with a crossbar. The scheme of calculation was applied in the form of a hingeless semicircular arch with fastened edges. The load is assumed to be evenly distributed over a portion of the central angle $\alpha = 90^\circ$. The following cases of loading were determined: (1) causing the appearance of flow, corresponding to the formation of plastic articulation, and (2) causing disruption. It is noteworthy that the calculated theoretical disruption load is, by amplitude, close to that determined experimentally (divergence 3.5%).

K. Ya. Mutsenek

Courtesy Referativnyi Zburnal, USSR
Translation, courtesy Ministry of Supply, England

4971. Zaytsev, V. P., Finite, elastoplastic, angular deformations (shearing) in basic, logarithmic and other systems of dimensions (in Russian), *Fiz. metallov i metallovedeniye* **2,** 1, 125–136, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3482.

A basic system is defined as one in which the deformations are in the usual manner represented by the ratio of the absolute increase in length (extension) to the original length. The fundamental relationships are stated for the modulus of elasticity, coefficient of lateral deformation, etc., in the basic and the logarithmic (so-called "true") systems. It is demonstrated that in making the calculations it is not permissible simultaneously to use logarithmic and "untrue" values such as the elasticity modulus etc.,

which in the logarithmic system are replaced by other, mathematical relationships.

Various expressions are developed for the amount of basic and logarithmic shear. Shear is defined as the relative difference of the tangents of the semi-angles between the principal directions of deformation. Small and finite deformations are correlated and a comparison is made between the relative shear used in practice, represented by the increment of the angle of deformation between two originally orthogonal straight lines, and the shear characteristic suggested by the author. With the help of the equations derived, the formulas of N. N. Davidenkov [*Izv. Akad. Nauk SSSR* no. 4-5, 309-312, 1944; *Zavod. Lab.* **15,** no. 5, 1949] and V. G. Ossipov [*Zavod. Lab.* **15,** no. 5, 1949] for the relationship between the angle of shear and the elongation are analysed. It is shown that the formulas of the present author are preferable.

V. G. Osipov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of supply, England

4972. Drozd, M. S., The optimum angle of initial elastoplastic torsion of a hexagonal bar (in Russian), *Nauch. tr. Stalingr. mekhan. in-ta* **2,** 153-163, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3486.

The problem of determining the optimum value of the initial, plastic deformation of a particular shaft is simply solved with the help of the diagram of elastoplastic torsion ($M - \theta$ diagram), the character whereof depends on the elastoplastic properties of the material as well as on the yield point in torsion τ_T.

A relationship $M_k - \theta$ is obtained, derived for the case of a round bar, and the conditions are defined in which this relationship can be applied to the case of a hexagonal bar. It is found that, in the presence of elastoplastic torsion, the hexagonal relationship between M and θ for a particular material (τ_T) can be described by an equation of the same kind as for the elastoplastic torsion of the round bar. At the same time, the values of M, θ and θ_T must depend on the geometric factors W_k and J_k characteristic for the hexagonal cross section.

An equation is derived for the least relative angle of initial torsion of a hexagonal bar, insuring the elasticity of the practical angle of torsion in dependence on the yield point of the material.

B. F. Romanchikov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4973. Vinogradov, A. I., The determination of elastoplastic displacements in bar frames (in Russian), *Trudi Kharkovsk. in-ta inzh. zh.-d. transp.* no. 26, 5-38, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3494.

The displacements in systems of rectangular rods loaded beyond the elastic limit are determined. The theory of flat sections is applied. The influence of tangential shearing stresses is neglected.

Author examines three stages of the stress condition for the cross section: the appearance of one yield region, the presence of two regions of yield, and the spread of yielding over the whole cross section. The curves of normal stresses due to the moment and the normal force are reduced to conditional curves of the elastic condition, for which the ordinary equations of stress and strain apply.

Determination of the displacements is effected by the Mohr formulas, introducing coefficients representing the development of plastic deformations: K_1 coefficient of reduction of the moment of inertia; and K_2 reduction of the cross-sectional area. Thus, determination of the displacements is based on the actual forces, but for the system with referred cross sections.

The suggested formulas are, for convenience in calculation, expressed in terms of the factors φ and ν, depending on the shape of the curve of moments for different segments of the bar, working in the first or second elastoplastic regions.

A number of tables are included for calculating the displacements, and numerical examples are given of the determination of displacements in bar frames beyond the limit of elasticity.

A. I. Strel'bitskaya

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4974. Trofimov, V. I., The elastoplastic work of mild, structural steel under simple and compound loading (in Russian), "Investigations of the strength, elasticity and creep of structural engineering materials," Moscow, 1955, 69-84; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3495.

Descriptions and experimental results are presented for the bilateral tension and compression of rectangular steel plates of the grades St. 0 and St. 3 in conditions of simple and compound loading beyond the elastic limit. The test plates of dimensions 80 × 80 mm and thickness 14-16 mm, and 40 × 800 mm with thickness 14 mm were loaded by means of a special device insuring uniform distribution of the external loads along the edges and freedom of displacement of points on the sample along the periphery. Under simple load with a ratio of longitudinal to transverse loading of ± 1, 1.06, 2.06, curves are plotted for the relationship between the stress intensity σ_i and the intensity of deformation c_i; it is found that the ratio of $\sigma_i \sim c_i$ can be generalised within ± 6.5%. It is concluded that "in view of the small slope of the curves $\sigma_i \sim c_i$ (to the axis c_i), the law of generalised curves can hardly find application to structural steels in the region of plastic deformation,"—the justification for which is not made clear. It is noted that at transition to the plastic state the ratio of the deformations on the area of flow no longer equals the ratio of the active stresses.

Under compound load with successive application of the longitudinal and transverse components of the same sign, it is found that exhaustion of the load-bearing capacity under loading in one direction preserves the capacity of the material for carrying additional loads of the same sign, in the direction perpendicular to the preceding. The shape of the curve of $\sigma_i \sim c_i$ markedly differs from that of the same curve under simple loading, and has no generalised character. Repeated removal of the load with succeeding additional loading along one of the force directions and unchanged value of the second load component leads to an increase in the local elastic limit.

Under loads of opposite sign the exhaustion of the load-carrying capacity by a single load component also exhausts the load-carrying capacity of the material in relation to the succeeding application in the perpendicular direction of a load of opposite sign. Hence it is suggested that in the tests the application of the second load should be accompanied by a reduction in the value of the load originally applied, when, on the condition of active deformation, the ratio $\sigma_i \sim c_i$ assumes the same form as for simple loading.

V. S. Lenskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4975. Khilchevsky, V. V., An investigation of the energy dissipation in turbine-blade steel at high temperatures (in Russian), *Izv. Kievsk. politekhn. in-ta* **18,** 109-116, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3752.

Author investigates the decay decrement in turbine-blade steel Zh. 1, at different temperatures. A description is given of the experimental installation which enables oscillograms to be recorded for the pure bending of a sample at different temperatures.

Curves are included showing the relationship between the logarithmic decrement and the stress value σ at different temperatures from 20 to 600°, and the dependence of the decrement on the temperature under fixed (constant) stress between 200 and

900 kg/cm². The "collapse" of the temperature relationship of the decrement, $\delta = f(t^\circ)$, is conditioned by the dispersion (solution) hardening of the steel. V. G. Timoshenko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4976. Kunin, N. F., and Sukhin, L. T., Plastic compression of metals at different temperatures (in Russian), *Trudi Chyabin in-ta mekhaniz i elektrifik. s. kh.* no. 5, 134–142, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2496.

Results are reported of the experimental investigations on the plastic compression of a number of metals at different temperatures, with the object of confirming that, with this type of form-change, the dependence of the stresses on the temperature has an exponential character over a wide range of temperatures. The investigations were carried out on copper, silver, aluminum, zinc, lead, tin, lithium, sodium and cadmium. The article includes a short review of the literature relevant to the subject matter.

F. A. Smirnov-Alyaev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4977. Marin, J., and Griffith, J. E., Creep relaxation in torsion (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **8**, 316–326.

Paper compares the results of calculations for solid circular shafts with the results of some carefully performed tests on plastic specimens. Though good agreement is shown, reviewer believes that the theoretical part of the paper is open to serious criticism. Stress-strain-time relations of the type $e_{ij} = s_{ij}/(2G) + s_{ij}\, g(t)\, h(J_2)$ are taken as a starting point. Contrary to a statement in the paper, these relations, due to Soderberg, are fundamentally different from the expressions for the creep rates introduced by Odqvist, and have been rejected rightly by most authors, in reviewer's opinion.

Considering that the simple tension and simple compression material constants are not the same, paper introduces one set of elastic constants for one principal direction and a second set for another principal direction. Though it is theoretically admissible in the case of a linearly elastic isotropic material to use different values for the bulk modulus of elasticity depending on whether the sign of the sum of the normal stresses is positive or negative, reviewer does not see how the use of different values for the modulus of rigidity to relate stress and strain in two different principal directions can be justified. A number of misprints make the paper difficult to read. J. F. Besseling, USA

4978. Campus, F., Creep and relaxation of steel at room temperature (in English), 9th Congrès intern Mécan. appl., Univ. Bruxelles, 1957; **8**, 312–315.

Paper gives some far-reaching conclusions with respect to creep and relaxation of steel at room temperature. They are based on experiments performed at a temperature of 21 ± 1 C on a large variety of steel bars, ranging from mild steel to very hard cold-drawn steel wire. It is mentioned that these experiments, of which no details are given, proved the statistical identity of the elastic limit, the creep limit, and the relaxation limit. It was found that in the case of steel without yield point the value of the creep after a definite time is proportional to the instantaneous permanent strain for equal stress. For steel with a yield point it is argued that, for an explanation of the observed phenomena in creep and relaxation tests, the yield elongation should be considered to be the significant quantity and not the yield stress.

J. F. Besseling, USA

4979. Biot, M. A., Dynamics of viscoelastic anisotropic media, Proc. Second Midwestern Conf. Solid Mech., Purdue Univ., Sept. 1955, 94–108.

Variational principle for linear viscoelastic stress analysis given by author is generalization of virtual work for elasticity. Principle of correspondence relates elastic and viscoelastic solutions by replacing elastic constants by rate operators. Motion of viscoelastic plate is presented as example of the former. Solution by means of the latter is also discussed. Partial modes for which space and time coordinates are separated, time giving a sum of decay behaviors, are discussed. E. H. Lee, USA

Failure, Mechanics of Solid State

(See Revs. 4950, 4962, 4983, 5213)

Mechanical Properties of Specific Materials

(See Revs. 4946, 4974, 4976)

Plasticity, Forming and Cutting

(See also Rev. 5215)

4980. Wegner, U., Theory of chip formation (in German), *ZAMM* **38**, 5/6, 200–206, May/June 1958.

This is a rigorous solution to a boundary-value problem in theory of elasticty. The complex variable techniques of Muskhelishvili are combined with von Mises criterion of yield to arrive at:

(1) The conclusion that the shear surface in an orthogonal cut is convex upward.

(2) Yet another and different equation relating shear angle to friction and rake angles.

Almost as important as the solution itself are the assumptions upon which it is based. Such simplifying assumptions necessarily limit the solution and should be kept in mind when interpreting it. Researchers in this field will find this solution interesting and a possible springboard for further investigations into the effects of elastic relaxation, anisotropy, and similar phenomena.

L. V. Colwell, USA

4981. Colwell, L. V., and Branders, H., Behavior of cutting fluids in reaming steels, *Trans. ASME* **80**, 5, 1073–1078, July 1958.

This investigation reveals that there can be considerable rubbing on the margins of reamers. This condition is intensified with more effective lubricants. Torque requirements increase, hole size and surface roughness decrease with increase in lubricant effectiveness. From authors' summary

4982. Chao, B. T., and Trigger, K. J., Controlled contact cutting tools, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-42, 9 pp.

A substantial reduction in power consumption, an increase in tool life, more effective utilization of cutting fluids, and improved surface finish on the machined workpiece have been achieved by suitably controlling the length of tool-chip contact. Reasons for these findings are discussed in terms of basic variables in chip formation mechanics.

Artificially restricted contact tools open new avenues for metal-cutting research. Machining data obtained with such tools provide further evidence of the invariant behavior of the dynamic shear stress of metals under high-speed cutting conditions, and

unfold interesting information on the intricate nature of tool-chip contact. From authors' summary

4983. Olberts, D. R., A study of the effects of tool flank wear on tool chip interface temperature, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-41, 5 pp.

A study of the effect of land wear upon the interface temperature between a carbide tool and an AISI 1015 steel workpiece is presented. The wear lands were ground on the tools to eliminate the effects of cratering and to produce uniform wear lands. The tool-work thermocouple technique was used to measure the interface temperature. A calibration of the thermocouple was obtained through the use of a technique suggested by Backer and Krabacher. The results at all feeds and speeds indicate that a wear land of 0.010 in. produces a lower interface temperature than a sharp tool. When the wear land increases beyond 0.010 in. to 0.020 and 0.030 in. the temperature again rises. Studies of the variation of the chip-thickness ratio with wear land indicated that the greater the land wear the lower the chip-thickness ratio.

From author's summary

4984. Mohan, R., and Pusb, V., Machine tool rigidity and machining accuracy, *J. Instn. Engrs. India* **38,** 1 (part 2), 65–73, Sept. 1957.

4985. Veller, S. Ia., and Likhtman, V. I., Laws governing lubrication when metals are worked under pressure, *Soviet Phys.-Tech. Phys.* **2,** 5, 989–995, Feb. 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27,** 5, 1087–1094, May 1957 by Amer. Inst. Phys. Inc., New York, N. Y.]

Authors conclude from their experiments in metal-working processes like wire-drawing, ball-sizing and upsetting that "a thin plasticized layer which is formed in the presence of an active lubricant has a much higher plasticity than the basic metal and can easily withstand supplementary deformation without breaking down; it thus guarantees the possibility of reaching a higher degree of metal reduction" than when the basic metal is worked dry. Also, that "with an active lubricant the effect of an increase in the hardness of the metal (under the punch) is considerably greater as a result of the considerable deformation of the surface layer. In connection with this, the possibility should be mentioned of a considerable increase in the effectiveness of such processes of metal surface layer hardening as shot-blasting and rolling. With active lubricants the degree of hardening reached by means of such processes, other conditions being equal, will be higher as a result of a greater plastic deformation of the surface layer. On the contrary, in processes such as grooving and shaping, where the greatest possible hardening of the surface layer must be obtained, a lubricant should not be used, as in these cases the presence of a lubricant produces a smaller deformation of the surface layers and therefore less hardening. These laws may be significant in the cutting of metals.

"With an active lubrication medium (when the lubricant penetrates below the cutting tool) the boundary compression of the metal and the formation of a leading crack in front of the cutting tool takes place with a lesser force than when dry. This stage of the cutting process is similar to the process of cylinder reduction or punch intrusion. Subsequently, at the expense of a lesser grabbing of metal (smaller deformation) in the shaving removed by the upper edge of the cutting tool and the lesser grabbing of the metal under the lower edge, the force of cutting also decreases in comparison to the nonlubricated operation.

"Thus, the mechanism of the lubrication media effects in various processes of metal-working under pressure is the same, but, depending on the nature of the pressure and the appearance of the deformation, it is manifested in different ways—in some, lubricants hinder the supplementary hardening of the surface layer of the worked metal; in other cases, on the contrary, they contribute to the hardening."

Not all of these conclusions are immediately apparent to this reviewer. References were made only to work done within the U.S.S.R, with no mention of other generally extensive studies in plastic deformation and in the effects of "punching."

C. C. Osgood, USA

4986. Fitzgerald, E. L., Design of a tape reader for numerically controlled positioning machines, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-204, 6 pp.

4987. Saxl, K., Transverse gauge variation in strip and sheet rolling, Instn. mech. Engrs., Prepr., 13 pp.

Large forces acting on the working surfaces of rolls in a mill producing strip or sheet will deform these rolls and, in an endeavour to obtain products of uniform thickness, the roll surfaces are ground to a shape which would compensate for this deflection. Unsupported rolls deform by bending and local compression of the surface, and the latter results in edge thinning. Work rolls of backed-up mills, in addition, deform owing to the effect of the elastic support afforded by the backing roll. The mechanism of deflection is investigated and remedies suggested.

Variation of thickness across the strip and particularly its redistribution is shown to be responsible for a number of troubles such as locked-up stresses in the rolled strip, buckling and waviness of strip, edge cracking, lateral deflection of rolls, etc. The performance of a wide four-high mill can be much increased, particularly when rolling narrow strip, provided the secondary deflection of the work roll is controlled. This enables use of more slender rolls which, in turn, makes it possible to roll harder metals to smaller gauges. From author's summary

4988. Nietsch, H. E., Mounting production machine, *Tool Engr.* **39,** 1, 105–107, July 1957.

Hydraulics; Cavitation; Transport

(See also Revs. 5025, 5070, 5071, 5073, 5080, 5081, 5205, 5224, 5232, 5233, 5265, 5268, 5271, 5277)

4989. Didkoviskii, M. M., and Radisnov, J. A., Comparison of formulas for velocities (in Russian), *Gidrotekh. Stroit.* **25,** 10, 43–50, Oct. 1956.

4990. Pavlovskii, S. S., Determination of scouring velocities downstream from a dam (protection against scour) (in Russian), *Gidrotekh. Stroit.* **25,** 8, 45–50, Aug. 1956.

4991. Chugaiev, R. R., A new method of determination of water movement under hydraulic structures (a simplified method of computation of uplift, rate of filtration, and the maximum pressure of outlet) (in Russian), *Gidrotekh. Stroit.* **25,** 6, 27–33, June 1956.

4992. Fedorov, E. P., Wave formation on spillways and its elimination (velocity distribution examined and variable width suggested) (in Russian), *Gidrotekh. Stroit.* **25,** 6, 48–51, June 1956.

4993. Altunin, S. T., and Musunov, J. A., River section design at intakes (a stable section checked for probable conditions) (in Russian), *Gidrotekh. Stroit* **25,** 5, 36–41, May 1956.

4994. Kuskov, L. S., and Polin, Kh. M., Maximum discharge for design of hydraulic structures (in Russian), *Gidrotekh. Stroit.* **25,** 4, 25–28, Apr. 1956.

Book—4995. Kislev, P. G., Handbook of hydraulic design [Spravochnik po gidravlicheskim raschetam], 2nd ed., Moscow-Leningrad, Gosenergoizdat, 1957, 352 pp. $2.80.

This is a manual for hydraulic engineers. It contains usual mathematical tables, auxiliary data, constants, collection of formulas and tables for all parts of hydraulics of open channels and conduits. Much attention is directed to nonuniform and unsteady flow. Many little known methods are presented for computation of open channels, accompanied with nomograms and tables. A chapter on turbines and pumps is added. Very few references are given, exclusively Russian. Manual is of great importance for designing engineers and is more up-to-date than previous Russian handbooks by N. N. Pavlovskiĭ, 1924, 1937, 1940, and M. A. Mostkov, 1954. S. Kolupaila, USA

Book—4996. Flemming, H. W., Deserts, dams and turbines [Wüsten, Deiche und Turbinen], Göttingen, Musterschmidt-Verlag, 1957, 444 pp. DN28.60.

This very attractive popular history of hydraulic engineering has as its principal chapters: old irrigation—forerunner of culture, defense against unfriendly water; waterways—vision of rulers; water—energy carrier; water distribution problems. Examples are taken from every field: Inca culture; Holland and Vermuyden; great American canals; Tennessee, St. Lawrence seaway; European waterways; big Russian problems; water-supply problems; development of turbines and water power. Book is extremely rich in facts and documentation; it is illustrated with many maps and pictures, and also with philatelic attractions, stamps from the realm of water.

This interesting book can be recommended as a splendid introduction to a course on hydrology and hydraulic engineering.

S. Kolupaila, USA

Book—4997. Brown, J. G., ed., Hydro-electric engineering practice: Civil engineering, Vol. I; Mechanical and electrical engineering, Vol. II; economics, operation, and maintenance, Vol. III. London, Blackie & Son Ltd., 1958, xxvii + 1189, xiii + 740, xxv + 473 pp. $55.86.

A luxurious edition presents modern British hydroelectric design, construction, operation and maintenance, for practice and study. It was written by a number of outstanding engineers and professors, including A. C. R. Altberg, J. Allen, A. W. Bishop, P. L. Blackstone, G. A. Bonnyman, T. M. Charlton, C. H. Davidson, P. E. Deriaz, O. Elsden, H. L. Ford, A. C. H. Frost, J. M. Gray, J. K. Hunter, C. H. Jaeger, H. G. Keefe, J. H. Lander, G. H. Lundgren, C. H. Morton. S. Neville, R. L. Olsen, P. J. Ryle, C. E. Stille, F. A. Weemys, with a general editor J. G. Brown. This symposium is unique in Britain: "Hydroelectric engineering" by A. H. Gibson was long out of date.

Various parts are well prepared and adjusted. Some details, however, could better correspond to contemporary level; e.g., the controversial definition of the roughness coefficient, pp. 88-89, follows the obsolete standard textbooks. This was not necessary because the Manning formula only is applied through all volumes. Backwater computation also could be more modern.

Extensive bibliography follows every chapter. Treatise is interesting for hydraulic engineers as a good introduction to British hydroelectric plants, their methods and aspects.

S. Kolupaila, USA

4998. Fauconnier, B., Scour downstream of dams (in French), *Houille blanche* **13**, 2, 123-144, Mar.-Apr. 1958.

The most satisfactory way of limiting scour downstream of a dam is to dissipate the energy of the water returned to the river by setting up a hydraulic jump on the apron over which the water flows. A method is suggested for calculating the simplest type of apron, which is horizontal. Under certain circumstances model studies can still further improve the effectiveness of such a structure.

Systematic tests carried out in connection with Cadarache dam dealt with the following factors: the longitudinal section of the structure and its roughness; the shape of the piers; the kind of rocks to be tipped downstream and how they were to be used; operating instructions. These tests brought out guiding principles for selecting the foregoing factors.

From author's summary

Book—4999. Govinda Rao, N. S., Design of siphons, New Delhi, Central Board of Irrigation and Power, Publication 59, 1956, viii + 122 pp.

Author deals with various types of siphons and explains theoretical considerations to the latest researches by Lakshmana Rao, applying the electrical analogy method to the study of volute siphons. Further model tests, the different aspects of design, and the problems of cavitation are considered. Especial attention is drawn to investigations on models and prototype working of volute siphons at Hirabhasgar Dam (Mysore State).

With its useful illustrations, fairly wide data, and clear explanations, based on author's own comprehensive research on the subject, the book will serve as a working guide for designs of siphons. For a future edition reviewer would like to suggest a general reference of previous publications.

P. Franke, Germany

Book—5000. Boldakov, E. V., and Andreiev, O. V., Stream crossings [Perekhody cherez vodotoki], Moscow, Avtotransizdat, 1956, 405 pp. $2.25.

This comprehensive treatise on hydrology and hydraulics of bridges and culverts contains investigations, estimation of maximum discharge, determination of a waterway, stream regulation, elements of bridge design, ferries and tunnels; culverts, size determination, design scour protection. Appendix gives data for different regions of Russia, Eastern Europe and Asia. Dr. Boldakov published his first book on river crossings in 1939, and two separate books on bridges and culverts in 1949 and 1950. This book could be of great interest for our bridge and highway engineers: it demonstrates a great progress in this particular field. S. Kolupaila, USA

Book—5001. Schmidt, M., Hydraulics of open channels [Gerinnehydraulik], Wiesbaden, Bauverlag GMBH, 1957, 241 pp. $6.50.

This good booklet contains general equations of the ideal and real liquids, energy and momentum principles in open channels, velocity distribution and friction losses, flow in straight channels, uniform and nonuniform, flow in bends, with variable discharge, bifurcation and junction; weirs, flow through orifices, siphon spillways, stilling pools. Author selected most exact and convenient methods for this particular part of hydraulics and tried to give a clear and easy solution for many practical problems of hydraulic engineering. He correctly explains the four correction coefficients for velocity distribution, but fails to introduce them into the formulas for nonuniform flow. Tables for backwater curves are given for rectangular and parabolic sections only.

A list of 139 references is included, mostly German, 16 English, 7 French, and 5 Italian. There are some mistakes, uncommon in German press; e.g., Abott and Hamphrey instead of Humphreys and Abbot. S. Kolupaila, USA

Book—5002. Ostrowski, J., Nomograms for hydraulic engineering design [Wykresy i tablice do obliczen wodno-melioracyjnych], Warsaw, Budownictwo i Architectura, 1956, 85 pp.

A set of 42 large-size nomograms for determination of the runoff for drainage systems, size of trapezoidal channels, drains, sewers and culverts, also for the backwater and excavation volumes, are presented, all in metric system of units. Nomograms are convenient to use and carefully prepared, mostly following the German tables by Schewior. It is regrettable, however, that the obsolete formula by Ganguillet and Kutter is still used exclusively for computation of open channels. S. Kolupaila, USA

5003. Dubin, Ch., A new proof of Allievi's equations (in French), *Houille blanche* **13,** 2, 145–147, Mar.–Apr. 1958.

5004. Chevalier, J., and Hug, M., Tests on the Cordéac surge tank concerning Thoma's condition (in French), *Houille blanche* **12,** 6, 888–902, Dec. 1957.

Tests carried out on the Cordéac installation have allowed a comparison to be made between the actual operational stability of a power house having a surge tank with a cross-sectional area approximately equal to the Thoma area and the stability range as deduced from the hypotheses on which the calculation of the Thoma condition is based.

The tests have also shown the important influence of any delay imparted to the governing sequence of the power house. Taking these delays into account has allowed the validity of the calculation hypotheses to be verified and, further, to give a possible explanation of the character of the results obtained from tests carried out on industrial installations by E. Scimemi.

From authors' summary by P. Franke, Germany

5005. Leonkov, A. M., Results of the investigation of a flow emerging from a flat grid directing the blades into the flooded area (in Russian), *Trudī Bezbitsk. in-ta transp. mashinostr.* no. 15, 31–41, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1757.

5006. Dolidze, D. E., The singularity of the solution of the boundary problem of a viscous compressible liquid (in Russian), *Trudī Tbilissk. matem. in-ta* **21,** 261–267, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 619.

In Graffi's article [*J. rational Mech. Analysis* **2,** no. 1, 1953], a method was indicated for the theorem of the singularity of solution of the equations for irregular movements of a viscous barotropic liquid. In the present article the same theorem is demonstrated for the singularity, applied by the same method, but the requirement of assigning compactness in the individual points of the boundary surface, by which the projection of the velocity on the normal might become negative, is replaced by a purely formal requirement of the limitedness of the relation ρ_0^{-1} div $\rho_1 u$, where ρ_0 is difference in closeness of the two proposed solutions and ρ_1 is closeness in the first solution. For evidence on the theorem in the work of Graffi and the present study the most effective supposition appears to be the assumption on the nonuniform character of the movement. Because of this it is impossible from these theorems, utilizing boundary transition, to obtain the theorem of the singularity of solution for steady flow of viscous incompressible and compressible liquids. N. A. Slezkin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5007. Gel'perin, N. I., and Vil'nits, S. A., Emission of liquids from deposits and openings of small diameter (in Russian), *Trudī Mosk. in-ta ton-Koi Khim. tekhnologii* no. 5, 27–36, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 442.

A description is furnished of the apparatus and the results of experiments on the determination of the coefficient of discharge, when eight types of liquids pass from cylindrical deposits with diameters $0.445 \leqslant d \leqslant 1.5$ mm and openings $0.25 \leqslant d \leqslant 1.3$ mm. The work was carried out under conditions applicable to the extraction of substances by means of solvents from liquid solutions in plant in the chemical industry. Experimental dependencies in the criterion aspect (dependence on Reynolds number and the complex appearing as the relation of the viscosity forces and the forces of capillarity) are given for determining the coefficient of discharge when the flow is in the droplet or stream form, and the boundaries are determined between these forms.

M. S. Volynskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5008. Trifonov, E. K., Method of calculation for a discontinuous wave in riverbeds (in Russian), *Izv. Vses. n.-i. in-ta, gidrotekhn.* **54,** 54–64, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 565.

A method of calculation for waves is described which makes use of characteristics in the case when the stream of the river can be viewed approximately as a series of rectilinear portions of various breadth. Using the known solutions for the case of the propagation of waves in a rectilinear channel, author obtains a solution of his problem by linking the solutions on the line of union of the portions. To obtain a closed system of equations relating to the parameters of the flow author uses a supplementary parity of discharge and energy on the line of union of the portions. The study is furnished with numerous illustrative examples.

Various rational methods are indicated to carry out the calculations in cases of sudden widening or narrowing of the channels.

N. N. Moiseev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5009. Melik-Nubarov, S. G., Hydraulic design of bottom-rocks (a formula derived for discharge) (in Russian), *Gidrotekh. Stroit.* **25,** 11, 37–39, Nov. 1956.

5010. Dulnev, V. B., Determination of head losses in trash racks (in Russian), *Gidrotekh. Stroit.* **25,** 9, 51–53, Sept. 1956.

5011. Perel'man, R. G., Investigation of the phenomenon of eddy formation (in Russian), *Trudī MAI* no. 38, 100–149, 1954; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 531.

Study is devoted to the problem of vortex formation when liquid flows out of a cylindrical reservoir through a round hole in the horizontal bottom. In the experimental apparatus the eddying was generated by artificial twisting of the flow in concentrated streams liberated into the reservoir tangentially to its axis. Author assumes, when examining the movement when the flow of the viscous liquid had steadied, that part of the pressure is expended on the creation of a turning movement of the viscous liquid, while the remaining pressure is used up "on creating a discharge." Author adopts the following principle of distribution of surrounding velocities c_u in the flow of the rotating viscous liquid: $r^x c_u = \text{const}$ where r is radius, x coefficient, allowing for pressure on internal friction and friction on the walls and bottom of the container. This coefficient is determined by means of experimental data. Author also puts forward a formula for the approximate calculation of the zone of pressure when eddying takes place. As regards preparing models of eddying, author comes to the conclusion that the determining influence in eddying is exerted by the viscosity, consequently the modeling should be carried out according to Reynolds, in which case the expression for determining Reynolds number R would be in the form of $R = \frac{rc_u}{\nu}$.

Attention is also given to determining the coefficient of discharge where there is liquid flow undergoing eddying. At the end

of the study a numerical example is given of the construction of the profile of the eddy.

O. F. Vasil'ev and N. A. Pritvits
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5012. Vasilishin, T. M., and Ipatova, Z. D., Experimental-theoretical investigation of vortex motion (in Russian), *Trudi Ufimsk. aviats. in-ta* no. 1, 17–27, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 532.

Vortex formation was studied on experimental apparatus; it consisted of a reservoir with a round hole in its horizontal bottom; the plan of the reservoir had the form of a spiral. Before starting the basic experiments, a series of preliminary experiments were carried out and also a theoretical investigation. The authors decided, on theoretical concepts of the problem, that the distribution of velocities in the vortex is governed by the principle of plane movement. This decision was borne out by the experiments. The basic experiments were carried out on models of five different scales, which permitted some conclusions to be made on the subject of modelling vortex formation. Experiments showed that the vortex dimensions were not governed by Froude's principle of similarity. The authors are of the opinion that the criterion of similarity is vortex formation with the Reynolds principle, which corresponds to the distribution of velocities in the vortex according to the principle of similarity. By methods of analysis of dimensions a one-dimensional correlation was obtained for the discharge coefficient μ. Experiments showed that with the increase of pressure H the value of μ increases, while with an increase in the diameter of the hole it decreases. In deducing the formulas, authors accepted the postulate that the discharge coefficient, when vortex motion was absent, would be just the same as when the liquid only passed through the ring section, that is, through the plane of the hole, assuming that the plane section of the vortex surface is level with the horizontal bottom.

From data furnished by the tests a curve is drawn, which enables the discharge coefficient μ to be determined, with pressure H and diameter of the hole d. μ having been determined, it is possible to calculate the geometrical parameters of the vortex and the discharge of liquid flow.

O. F. Vasi'lev, and N. A. Pritvits
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5013. Isaakyan, S. M., Vortices at hydrotechnical installations and their quantity flow capacity (in Russian), *Izv. Akad. Nauk Arm. SSR* **8**, 3, 101–112, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 533.

The study commences with a description of the features accompanying vortex formation in hydrotechnical installations. A short analysis is given of work done on vortex formation. The object of the investigation was the determination of the flow capacity of the vortex, forming in the stream under the grid, in relation to the geometrical and hydraulic parameters of the installation.

The question of the mechanism of vortex formation was, however, not touched on. The criterion of the estimate of flow capacity was the quantity of sawdust passed by the vortices through the grid opening. The experiments were carried out in a straight trough partially blocked by plane grids immersed in the water. Eighty such tests were carried out and also another 150 to determine the flow capacity of artificial vortices, generated when passing through screen vortex producers, situated at the walls of the trough. As the result of scrutiny of the experimental data, one-dimensional correlations were obtained, by means of which the flow capacity of vortices were determined, both for natural as well as for artificially promoted, when wood sawdust was utilized as the floating material. A formula was also given for the passage to the outlet of another material having a different volumetric weight. Author recommended the use of the one-dimensional correlations for preliminary calculations, and also for the modelling of vortices.

O. F. Vasel'ev and N. A. Pritvits
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5014. Roi, N. A., The initiation and development of ultrasonic cavitation; survey (in Russian), *Soviet Phys. (Acoustics)*, **3**, 1, 1–16, Dec. 1957. [Translation of *Akust. Zh. Akad. Nauk SSSR* **3**, 1, 3–18, Jan.–Mar. 1957, by Amer. Inst. of Phys., Inc., New York, N. Y.]

Main conclusions from this brief survey are:

(1) Gas-filled nuclei are chiefly responsible for the strength of a liquid, although little is known about the causes which give rise to them or to their distribution. The number of such nuclei in a liquid can be diminshed on degassing, by increasing pressure or lowering temperature.

(2) Stable nuclei can move to places where acoustic pressure has been raised and can increase their dimensions. At high frequencies only sufficiently small nuclei can cavitate.

(3) The observed value of the strength of a liquid is affected by several things, including the number of stable nuclei, the volume of the region of increased acoustic pressure, acoustic frequency, and irradiation time.

(4) Only qualitative information can really be obtained concerning the effects of individual factors (e.g. viscosity, etc.) on the observed value of the strength of a liquid. This is because other factors which affect results cannot be efficiently monitored.

(5) There is little reliable information concerning the noise whose level can serve as the measure of shock-intensity which occurs during the collapse of cavities.

G. Power, England

5015. Milam, A. B., and Morgan, W. B., Section moduli and incipient cavitation diagrams for a number of NACA sections, *David W. Taylor Mod. Basin Rep.* 1177, 10 pp. + 4 tables + 9 figs., Oct. 1957.

The section moduli for the TMB EPH, NACA 16, 65A and 66 TMB modified sections are given in this report along with incipient cavitation curves for the NACA 16, 65A, 0000–1.10 40/1.575 sections with a = 1.0 and 0.8 and the NACA 66 TMB modified section with an a = 0.8 mean line.

From author's summary

Book—5016. Vladislavlev, L. A., Testing of mechanical equipment of water power plants [Ispytanie gidromekhanicheskogo oborudovaniia gidroelektricheskikh stantsiĭ], Moscow-Leningrad, Gosenergoizdat, 1957, 152 pp.

This is a concise and well-elaborated manual for examination of mechanical installations and their efficiency tests; current meters, weirs, Gibson method are described. Author covers mechanical checking of valves, lubrication, automatic control; investigation of vibrations and deformations; thermic tests. Booklet is a useful guide for hydraulic and power engineers.

S. Kolupaila, USA

5017. Tseitlin, A. S., Equation of the uniform flow in pipes and its application for loss computation (a formula with an additional viscosity factor developed) (in Russian), *Gidrotekh. Stroit.* **25**, 9, 54–56, Sept. 1956.

5018. Egiasarian, B. O., Approximate determination of unsteady flow under power plant regulated daily. (A formula for a typical discharge fluctuation) (in Russian), *Gidrotekh. Stroit.* **25**, 7, 48–51, July 1956.

Incompressible Flow: Laminar; Viscous

(See also Revs. 5107, 5169, 5187, 5193, 5194, 5223, 5226, 5239, 5240, 5242, 5243, 5244, 5245)

5019. Muller, K.-H., On the theory of spiral vortex (in German), *ZAMM* **38,** 5/6, 179–187, May/June 1958.

The approximate solutions of Navier-Stokes' equations are derived in the case of the flow due to an infinitely long, straight spiral vortex filament in the axial symmetric, homogeneous and steady flow field bounded by the corn-wall having arbitrary angle. The term spiral vortex filament (Wirbelstrahl) is defined as the vortex filament combined with a source or sink line. The author intended to apply these solutions for the field of flow due to vortices such as tornadoes and cyclones, etc. The velocity and pressure distribution are approximately expressed in terms of supergeometric functions. The stream lines are graphically shown.

H. Arakawa, Japan

5020. Howard, L. N., Divergence formulas involving vorticity (in English), *Arch. rational Mech. Analysis* **1,** 2, 113–123, Sept. 1957.

Author investigates and classifies all vorticity divergence formulas such as

$$f(\vec{x}, \vec{q}, \vec{\Omega}) = \operatorname{div} \vec{V}(\vec{x}, \vec{q}, \vec{\Omega})$$

as well as analogous two-dimensional formulas. Conservation theorems can be obtained by applying the divergence theorem and formulating sufficient conditions for the boundary integral to vanish. Formulas are found for general and solenoidal flows in three and two dimensions.

M. D. Friedman, USA

5021. Kondrat, K. I., Induction velocities of vortex strings of any shape (in Russian), *Trudĭ Leningr. in-ta aviats. priborostroeniya* no. 4, 3–15, 1953; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1858.

5022. Stewartson, K., On the motion of a sphere along the axis of a rotating fluid, *Quart. J. Mech. appl. Math.* **11,** 39–51, Feb. 1958.

If the fluid is supposed undisturbed far upstream, there is an indeterminacy to the solution of the *steady* motion, due to the existence of wave-like solutions. Author shows that if the above hypothesis holds in *unsteady* motion, wave-like solutions are excluded.

The solution for the motion of a sphere is then determined using the preceding restriction. It is found that for $2\Omega a/W = 5.76$ (Ω angular velocity of the fluid, a radius, and W velocity of the sphere) both the stream function and the drag become infinite. The hypothesis of undisturbed fluid motion far upstream has then to be abandoned (regime of cylindrical motion obtained experimentally by G. I. Taylor).

A delicate analytical discussion clarifies an old, curious, and difficult problem.

A. Craya, France

5023. Troskolanski, A. T., Principles of fluid mechanics in cylindrical coordinates (in Polish), *Archiwum Hydrotechniki, Warsaw* **5,** 1, 39–80, 1958.

Cylindrical coordinates are particularly convenient for the study of axially symmetrical flow. They were applied by Prašil in 1903, by Lorenz in 1910, by Witoszyński in 1916, and by author in his "Applied hydromechanics" in 1951 [AMR **9** (1956), Rev. 482]. Author demonstrates the application of this system to three-dimensional, rotational and irrotational, symmetrical two-dimensional and one-dimensional flow. Theorems by Thomson and by Helmholtz are checked. A thorough and lucid study.

S. Kolupaila, USA

5024. Wood, W. W., Three-dimensional motions in closed regions, at large Reynolds number, *Aero. Res. consult. Comm. aero. Res. Lab. Melbourne, Austral. Rep.* 106, 16 pp., Nov. 1957.

Author resolves lack of uniqueness in interior time-dependent boundary-value problem of incompressible fluid with small localized viscous effect. He applies two additional boundary conditions, the simplest of which prescribes a value for the time derivative of the total head on a streamline. Reviewer believes second condition is consequence of conservation laws.

K. M. Siegel, USA

5025. Sacks, G. M., Skin friction experiments on rough walls, *Proc. Amer. Soc. civ. Engrs.* **84,** HY3 (*J. Hydr. Div.*), Pap. 1664, 20 pp., June 1958.

It is shown that effects of roughness on the skin friction of a flat plate at very high Reynolds numbers can be investigated by means of experiments in a pipe at moderate Reynolds numbers, provided the surface roughness of the flat plate can be reproduced exactly in the pipe. Some experiments on these lines are described, using air at speeds up to 270 fps in a pipe of 2-in. diameter. It was found that the effect of roughness consisting of widely spaced peripheral wires in the pipe could be correlated with the drag of a circular cylinder on a plane wall, as obtained from the measured pressure distribution around the cylinder.

From author's summary

5026. Tao, L. N., Note on turbulent friction factor of flow through narrow annuli *J. aero. Sci.* **24,** 12, p. 915 (Readers' Forum), Dec. 1957.

5027. Pierre, B., Flow resistance in cooling fluids used in refrigeration cycles (in Swedish), *Kyltekn. Tidskr.* no. 6, 225–236, Dec. 1957.

5028. Lin, C. C., On uniformly valid asymptotic solutions of the Orr-Sommerfeld equation (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles 1957; **2,** 136–148.

The stability theory of incompressible laminar flow ultimately leads to the study of a single fourth-order linear differential equation with the highest-order derivative multiplied by the small parameter $(\alpha R)^{-1}$. Approximations to four independent solutions are required for large values of αR. In the past, these have been derived in a variety of ways, none of which has been entirely satisfactory. One of the main difficulties is to include a certain critical point inside the region of validity in the plane of the complex independent variable. In the present paper, the author derives asymptotic solutions that are uniformly valid in a finite region containing the critical point. The method, in contrast to earlier methods, includes a systematic procedure for finding higher-order approximations, and appears to be more accurate even in the first approximation.

D. W. Dunn, Canada

5029. Kiselev, P. J., Movement of a liquid with a variable mass (in Russian), *Sb. tr. Mosk. inzb.-stroit. in-ta* no.9, 5–40, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 427.

Author arrives at the following system of equations for the movement of a liquid of variable mass

Equation of the movement

$$X - \frac{1}{\rho}\frac{\partial p}{\partial x} - \left[\frac{\partial}{\partial t}(U\omega_s) + U\frac{\partial}{\partial s}(U\omega_s)\right]\frac{(u-u_n)}{U\omega_s} = \frac{du}{dt}$$

$$Y - \frac{1}{\rho}\frac{\partial p}{\partial y} - \left[\frac{\partial}{\partial t}(U\omega_s) + U\frac{\partial}{\partial s}(U\omega_s)\right]\frac{(v-v_n)}{U\omega_s} = \frac{dv}{dt}$$

$$Z - \frac{1}{\rho}\frac{\partial p}{\partial z} - \left[\frac{\partial}{\partial t}(U\omega_s) + U\frac{\partial}{\partial s}(U\omega_s)\right]\frac{(w-w_n)}{U\omega_s} = \frac{dw}{dt}$$

Characteristic equation being

$$\rho = \phi(p, t^\circ)$$

Equation of continuity of mass of the liquid flow

$$\frac{\partial \rho}{\partial t} + \frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z} = \rho \frac{dQ}{dx, dy, dz}$$

Rule for the change of mass of the liquid flow

$$\rho \frac{dQ}{dx,\ dy,\ dz} = f(x, y, z, t)$$

Conditions of combination

$$u_n = f_1(x, y, z, t)$$

$$v_n = f_2(x, y, z, t)$$

$$w_n = f_3(x, y, z, t)$$

In these equations X, Y, Z, ρ, p have the same meaning as in the customary equation in hydrodynamics; u, v, w, U are components of speed and the total speed of the basic flow: ω_s an elementary plane normal to the direction of the basic flow; s the direction along the line of flow; ρdQ the mass of liquid per second joining the basic flow in the region dx, dy, dz; u_n, v_n, w_n speed of that mass. The functions entering the last four equations are arbitrary in value. Thus, assuming the existence of only one (the basic) flow, the presence of processes of appearance and disappearance of mass when there is arbitrary intensity of such processes (the first of the last four equations) is admissible, and also the possibility of acceptance of arbitrary speeds, characterizing the mass joining up (the three remaining equations).

Meanwhile the physical aspect of the phenomenon should result in the application of additional conditions. For a full consideration of the problem, boundary conditions should have been laid down, and in all the dynamic equations terms should have been introduced to take account of the energy losses.

When studying single dimensional movement such terms are introduced by the author as integral functions. The last do not materially differ from analogous functions, obtained earlier by other authors.

V. M. Makkaveev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5030. Sadovskaya, N. N., The circulation of air currents in the presence of a concentrated air supply (in Russian), *Trudi nauch. sessiyi Vses. N.-i. in-ta okhrany truda* no. 4, 23–42, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3244.

Results are presented of investigations on a turbulent, isothermal flow, propagating in a space bounded by rigid walls.

I. A. Shepelev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5031. Shorin, V. G., and Kelarev, Yu. I., The resistance of an air medium when haulage by locomotive takes place underground (in Russian), *Nauch. tr. povopr. gorn. dela. Mosk. gorn. in-ta* no. 15, 117–121, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 416.

Existing method of calculating the air resistance of a train in transit through a tunnel is extended to cover the case of rolling stock with trucks filled with bulk loads. An example of the calculation is given.

O. V. Yakovlevskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5032. Anissimov, S. A., Determination of gas leaks through the piston rings of compressors (in Russian), *Trudi Leningr. politekhn. in-ta* no. 177, 158–172, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2945.

The leakage of gas past piston rings is identified by the author with the flow of a gas through a labyrinth seal. To determine the leakage at different parts of the working cycle of the compressor, the hydraulic equations and the equations of the working cycle of the compressor are examined jointly. Author divides the entire cycle into two sections with subcritical and hypercritical gas flow through the piston rings. The mean value of the gas leakage is determined by the sum of the outflow during the compression and expansion strokes. Calculations are developed for the four particular problems presenting the greatest interest.

V. I. Kirsanov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5033. Anissimov, S. A., Experimental proof of the formulas for calculating gas leaks past the piston rings of a compressor (in Russian), *Trudi Leningr. politekhn. in-ta* no. 177, 173–179, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2946.

Results are presented of an experimental verification of the formulas used for calculating gas leakage past the packing rings of pistons, suggested by the present author in preceding review. The experimental verification was performed on a special test bench, simulating the high-pressure stage of a piston air compressor. The tests were made with the piston in motion and at rest, with constant and variable pressures in the cylinder, and with a varying number of piston rings (from 20 to 10).

The results confirm that it is possible to use the derived formulas for calculating the leakage of gas past piston packing rings.

V. I. Kirsanov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5034. Kostin, A. I., The semi-pressure head condition in pipe lines (in Russian), *Sb. tr. Novocherkas. inzh.-melior. in-ta* **5**, 101–110, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 529.

5035. Van der Hegge Zijnen, B. G., Measurements of the velocity distribution in a plane turbulent jet of air, *Appl. sci. Res. (A)* **7**, 4, 256–276, 1958.

Extensive measurements of velocity and turbulence distributions are made in two-dimensional jets of air at Reynolds number of 13,300. The larger jet (same Reynolds number) was found to spread slightly faster. Velocity distributions were Gaussian to good approximation. Mixing lengths and Austausch coefficients are calculated and are found to vary over the cross section, contrary to hypotheses used in various existing theories.

A. M. Kuethe, USA

5036. Van der Hegge Zijnen, B. G., Measurements of the distribution of heat and matter in a plane turbulent jet of air, *Appl. sci. Res. (A)* **7**, 4, 277–292, 1958.

Measurements of temperature and matter (city gas) distributions were made at many stations in the two-dimensional jets used in the work reported in the previous review. It was found that mass and heat transfer follow essentially identical laws. The ratio of the coefficient of heat (or mass) transfer to that of momentum transfer as functions of y/x shows variation from unity at outer edge to a maximum of 2.4, and then decreasing again to 1.7 at the center of the jet. Agreement with existing theories is satisfactory only if this variation is taken into account.

A. M. Kuethe, USA

5037. Van der Hegge Zijnen, B. G., Measurements of turbulence in a plane jet of air by the diffusion method and by the hot-wire method, *Appl. sci. Res. (A)* **7**, 4, 293–313, 1958.

The turbulence was measured in the two-dimensional jets used in the work described in the preceding two reviews. These measurements (hot-wire) are compared with the values derived from

measurements of heat diffusion in the wake of a heated wire placed at various positions in the jet. The measured velocity fluctuations are invariably appreciably smaller than those derived from the diffusion measurements. Also the measured Reynolds stress—$\rho\overline{u\,v}$ is lower than that derived from the distribution of mean velocity by means of the momentum relations. No reasons are given for the discrepancies. A. M. Kuethe, USA

5038. Sanyal, L., Jet issuing in all directions from a thin slit round a circular cylinder of small radius containing liquid under pressure, *ZAMP* **8,** 2, 156–159, 1957.

Author calculates the flow of a three-dimensional laminar jet which issues from a narrow circular slit in the wall of a tube of circular cross section under pressure in the radial direction. With the simplification of the boundary-layer theory the differential equation for the stream function can be integrated in closed form. A simple formula for the total mass flux from the slit is obtained. H. Schlichting, Germany

5039. Polyushkov, A. G., The theory of the jet in the initial turbulent jet region in a concurrent traveling flow (in Russian), Thesis, Moscow Higher Technical College, Moscow, 1955; *Ref. Zh. Mekh.* 1956, Rev. 4364.

5040. Lebedev, L. L., The unsteady motion of a contour in a fluid (in Russian), *Ucb. zap. Kazanskogo in-ta* **116,** 1, 50–54, 1956; *Ref. Zh. Mekh.* no. 3, Rev. 3020.

For the case of the unsteady motion of a closed contour in an ideal incompressible fluid, resting in infinity, the following problem is examined: on the required moving contour, given the velocity distribution in the form of the function of the length of arc s and time t:

$$V_\tau = f_1(s,\ t);\quad V_n = f_2(s,\ t)\quad (0 \leqslant s \leqslant l)$$

(V_τ, V_n – tangent and normal components of the velocity; l – length of arc of the contour); required: to determine the form of its contour and its motion. This problem, for any fixed instant of time, can be reduced to the reciprocal boundary problem for a function analytical for the region external to the required contour, and represented by the complex velocity potential: $w = \varphi + i\psi$ (φ velocity potential, ψ stream function). The solution of the resulting reciprocal boundary problem is found by the methods of the theory of reciprocal boundary problems, developed by G. G. Tumashev and M. T. Nuzhin. After determining the form of the contour, its law of motion is easily found.

In formulating the problem, author assumes that the required contour is indeformable, i.e. its form does not change with variation in time. In the final formula for the coordinates of the required contour, however, as follows from the equation for determining the auxiliary parameter γ (length of arc of the unit circle in the auxiliary plane):

$$\varphi\ (s,\ t) + i\psi\ (s,\ t) = \omega\ (e^{i\gamma},\ \varphi_0,\ \psi_0)$$

there will enter the time t. Actually, it is probably possible to segregate only a particular class of functions $f_1(s,\ t)$, $f_2(s,\ t)$, such that to any pair of functions taken from this class, there will be a corresponding, indeformable contour in the plane of the flow.

G. N. Pykhteev
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5041. Yakoob, B. M., Large-scale flow pulsations in a diffusor (in Russian), *Trudi Rostovsk. in-ta, inzb. zh.-d. transp.* no. 18, 138–148, 1954; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2902.

The longitudinal velocity pulsations of a diffusor flow have been measured by total-pressure tubes and throttled liquid manometers, the indications whereof were recorded cinematographically. In the presence of a valve in front of the diffusor entry and an unsymmetrical entry flow (in a direction perpendicular to the axis of the diffusor), longitudinal pulsations in different pairs of points on the periphery of the discharge cross section of the diffusor are found to be differently phase-displaced with reference to the location of the points. In the absence of a valve and a symmetrical air feed, the pulsation, as well as the mean flow, disclose an axial symmetry.

For measuring transverse velocity pulsations and pressure pulses, a static tube was used with two separate orifices, individually connected in the first case to the different legs of a single differential manometer, and in the second case, to different manometers, The transverse pulsations are in order of magnitude close to the longitudinal.

The velocity increment accompanied by an increase in efficiency of the diffusor causes a decrease in the magnitude of the pulsations, referred to the mean velocity. B. A. Fidman
Courtesy Referativnyi Zhurnal, USA
Translation, courtesy Ministry of Supply, England

5042. Filonenko, L. A., New method of calculation of an unsteady movement of a gas in the piping system of a high-speed internal combustion engine (in Russian), *Trudi Khar'kovsk. aviats. in-ta* no. 16, 141–151, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 377.

Compressible Flow, Gas Dynamics

(See also Revs. 4965, 5099, 5114, 5123, 5162, 5163, 5164, 5197)

5043. Lay, J. E., An experimental and analytical study of vortex-flow temperature separation by superposition of spiral and axial flows, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-71, 13 pp.

Paper reports on an experimental and analytical study of compressible flow in a uniflow vortex tube. Its purpose is to provide a better understanding of the separation of a gas stream into regions of high and low stagnation temperatures, there being at present little agreement as to the theory of operation. The problem is first approached from the experimental standpoint. A large, multipurpose vortex tube is so designed and built that pressure, temperature, and velocity traverses can be taken at six different stations throughout the length of the tube by means of hypodermic probes. Velocities are checked by means of a miniature hot-wire anemometer. Data are taken for different runs of inlet pressures and plotted against radial distance. Flow visualization is obtained by means of liquid injection.

The analytical study consists of using superposition for the solution of the flow equations. It begins with potential vortex flow in the plane. The solution of this flow is characterized by the existence of sonic or limit circles. Superposition of a sink flow to the vortex solution yields a spiral flow in the plane. The general solution in space is obtained by addition of a uniform axial velocity to the spiral flow. When viscosity effects are considered, the potential vortex changes into a forced vortex, and the solution becomes a superposition of a viscous compressible sink to a forced vortex. Performance or stagnation temperature separation is expressed as function of the ratio of vortex strength to sink strength. From author's summary

5044. Shercliff, J. A., Some generalizations in steady one-dimensional gas dynamics, *J. Fluid Mech.* **3,** 6, 645–657, Mar. 1958.

Paper gives a unified mathematical treatment of isentropic nozzle flows, Rayleigh, Fanno and related processes to bring out dominant role of sound speed for arbitrary fluids in thermodynamic equilibrium. H. C. Levey, Australia

5045. Tempelmeyer, K. E., and Self, L., A note on isentropic compressible flow of air with variable specific heats, *J. aero. Sci.* **25,** 4, 278–279 (Readers' Forum), Apr. 1958.

5046. Bulakh, B. M., Theory of nonlinear conical flows (in Russian), Nauch. ezhegodnik. za 1954, Saratovsk. un-ta, Saratov, 1955, 694–695; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1593.

5047. Valentine, E. F., An approximate method for design or analysis of two-dimensional subsonic-flow passages, *NACA TN* 4241, 18 pp. + 9 figs., Apr. 1958.

A graphical method for the determination of subsonic flow fields is based on a measurement of the streamline curvature. Calculations are eliminated by precomputed charts.

G. Guderley, USA

5048. Van Dyke, M. D., The paraboloid of revolution in subsonic flow, *J. Math. Phys.* **37,** 1, 38–51, Apr. 1958.

The title of the article is rather unfortunate in that it gives no guidance to the uses of information found.

A refined analysis of the paraboloid is made for forebody applications to get improvement over the linearized treatment of bodies of revolution at zero incidence. Second-order small-disturbance theory; second-order slender-body theory; the Janzen-Rayleigh expansion and M^2 and $(\gamma + 1)M^4$; and interconnection between these methods are used. The error, a multiple of an eigensolution, obtained with the small-disturbance or slender-body theory can be corrected from information obtained from the Janzen-Rayleigh method applied to a paraboloid of equal nose radius. The latter method is used to obtain an expansion for the streamwise component of the surface velocity for the paraboloid $Z^2 = 2x/\rho$. Comparison with the parabolic cylinder shows the same surface velocity contribution by the incompressible flow term, that computed by Munk in 1935. The first compressibility correction terms however show a ratio of about 2 for parabola to paraboloid. A simple asymptotic form is found for the stagnation neighborhood. Some numerical results are plotted for the case $M = 0.6$.

The velocity potential in terms of M and the nose radius ρ is also found from the small-disturbance theory with and without the interconnection with the Janzen-Rayleigh expansions. Also the slender-body solution of velocity potential and surface speed is derived by an interconnection with that found for the small-disturbance theory, and numerical results exhibited in the plot referred to earlier show failure of this solution in the stagnation region. Finally, simple rules are set down for correcting velocities in the nose region of symmetrical two- and three-dimensional bodies as found by the small-disturbance theory.

M. G. Scherberg, USA

5049. Power, G., and Smith, P., Compressible fluids in steady two-dimensional subsonic flow, *Appl. Sci. Res. (A)* **7,** 5, 357-368, 1958.

The correct differential equations for adiabatic flow past a large number of profiles are developed and a method of successive approximations to the solutions of these equations and several examples are given, with the results compared with those obtained by other means. Any desired accuracy can be obtained even when the flow approaches subsonic speed. A method for constructing channels suitable for high-speed subsonic flow is also outlined.

J. F. Lee, USA

5050. Woods, L. C., Theory of aerofoils on which occur bubbles of stationary air, *Aero. Res. Counc. Lond. Rep. Mem.* no. 3049, 15 pp. + 6 figs., 1957.

Author treats the problem of subsonic inviscid compressible flow over a wing on which a closed separation bubble is located. Practical cases of this phenomenon occur behind spoilers and split flaps. In developing the theory the positions of both flow separation and reattachment are assumed known and the pressure in the bubble is assumed constant. The flow solution is derived using the solution of Laplace's equation within the unit circle with mixed boundary conditions, and is based on using von Karman's approximation in the differential equation of compressible subsonic flow. The "mapping" approximation used is that the overall mapping is only negligibly affected by small values of incidence, flap deflection, spoiler height or split-flap angle. With the solution so obtained, expressions for the pressure distribution, spoiler height, lift coefficient, moment coefficient, and thin airfoil stall are given and discussed.

R. W. Detra, USA

5051. Rao, G. V. R., Exhaust nozzle contour for optimum thrust, *Jet Propulsion* **28,** 6, 377–382, June 1958.

A method for designing the wall contour of an exhaust nozzle to yield optimum thrust is established. A method of Sauer is used to analyze the transonic flow in the throat region in terms of the radius of curvature of the nozzle wall. The flow immediately down-stream of this region can be determined by the method of characteristics. For computing thrust a control surface is introduced which passes through the exit of the nozzle and is proved to be a characteristic surface. Maximizing the thrust gives conditions for the wall slope at the exit and for the nozzle length, when the exit Mach number is prescribed. The solution of the variational problem yields certain flow properties on the control surface, and the nozzle contour is then constructed by the method of characteristics. An example is carried out and typical nozzle contours are given.

W. Wuest, Germany

5052. Pitts, W. C., Nielsen, J. N., and Kaattari, G. E., Lift and center of pressure of wing-body-tail combinations at subsonic, transonic, and supersonic speeds, *NACA Rep.* 1307, 37 pp. + 3 tables + 16 figs., 1957.

A method is presented for calculating the lift and center-of-pressure characteristics of circular-cylindrical bodies in combination with triangular, rectangular, or trapezoidal wings or tails through the subsonic, transonic, and supersonic speed ranges. The method is restricted to wings which are unbanked and do not have sweptback trailing edges or sweptforward leading edges. The method is further restricted to small angles of attack and small angles of wing and tail incidence. The wing-tail interference is treated by assuming one completely rolled-up vortex per wing panel and evaluating the tail load by strip theory. A numerical example is included to show that the computing form and design charts presented reduce the calculations to routine operations. Comparison between the estimated and experimental characteristics show that the lifts were estimated to within ±10% and the centers of pressure were estimated to within ±0.02 of the body length.

From authors' summary by J. Lukasievicz, USA

5053. Elrod, H. G., Jr., Note on a solution of the telegraphist's equation applicable to supersonic shear flow, *J. Math. Phys.* **37,** 1, 66–68, Apr. 1958.

An integral equation occurring in the theory of supersonic shear flow past thin airfoils is solved with the aid of the Laplace transformation, thus simplifying some work of C. C. Chang and J. Werner [AMR **6,**(1953), Rev. 962]. Author's final result is, however, still not in its simplest form.

K. Stewartson, England

Book—5054. Ferri, A., The aerodynamics of supersonic flows (in Russian), Moscow, Gostekhizdat, 1953, 464 pp. + illus., *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2768.

Book is an exposition of principally theoretical conclusions from the engineering standpoint, applied to the solution of a number of problems concerning the steady flow of an inviscid, super-

sonic fluid around bodies of varying shape, with stress laid on the application of the method of characteristics. A recapitulation of the contents of its 15 chapters and appendix gives the scope of the work. Chapter 1—General principles; Chapter 2—Theory of plane flow, potential flow, characteristic curves, small perturbations; Chapter 3—Theory of shock waves; Chapter 4—Theory of the plane flow, interaction and reflection of compression jumps and rarefaction waves; Chapter 5—Theory of plane flow, theory of characteristics for turbulent flows; Chapter 6—Measurement of the physical parameters of a supersonic flow; Chapter 7—Supersonic profiles; Chapter 8—Two-dimensional nozzles; Chapter 9—Supersonic diffusors; Chapter 10—The general relationships of three-dimensional (spatial) flows; Chapter 11—Investigation of the aerodynamics of bodies of rotation by means of the theory of small perturbations; Chapter 12—Flow around conical bodies, the hodograph method; Chapter 13—Characteristics in a spatial flow; Chapter 14—Pressure resistance of supersonic aerofoils; Chapter 15—Lift and induced drag of supersonic aerofoils.

The appendix contains tables for the calculation of compressible flows. A separate insert gives, on a large scale, the epicycloid grid, and a diagram of shock waves.

L. V. Ovsyannikov
Courtesy Referativnyi Zhurnal, USSR
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5055. Lock, R. C., An extension of the linearized theory of supersonic flow past quasi-cylindrical bodies, with applications to wing-body interference, *J. Fluid Mech.* **4,** 1, 33–63, May 1958.

The effect of an arbitrary body distortion on static stability at supersonic speed and the effect of wing-body interference on rectangular wings mounted on a cylindrical body are discussed by linearized theory of supersonic flow past quasi-cylindrical bodies of circular cross section.

Numerical values of functions appearing in calculation are given. The drag calculations in wing-body interference are compared with the results of supersonic area rule.

Reviewer thinks that such comparison has no important significance in an engineering sense since the starting assumption is not so strict in regard to real states.

M. Kataoka, Japan

5056. Willis, D. R., and Glassman, I., The mixing of unbounded coaxial compressible streams, *Jet Propulsion* **27,** 12, 1241–1248, Dec. 1957.

A report based on a rather careful series of total pressure and total temperature measurements on a primary jet originating in a 2½-in. diam nozzle, surrounded by an annular secondary jet. Primary jet Mach numbers covered a range to 2.6, while secondary jet speeds were all subsonic. In some of the experiments, the primary jet was heated to produce a 43% increase in stagnation temperature.

The parametric dependence of the spread of momentum and energy boundaries are discussed and the results compared with analytical results based upon phenomenological models. Explanatory remarks in authors' conclusions lead reviewer to wonder whether it would not be possible to construct a momentum-spread similarity parameter by use of a Reynolds number based on relative velocity, combined in same fashion with the secondary stream Mach number. The chief obstacle to progress, in any case, is the continued limited understanding of the basic nature of turbulent shear flows. D. Bershader, USA

5057. Galezowski, S. H., Effects of probe tip geometry and size on measurements in a laminar boundary layer in supersonic flow, *Univ. Toronto Inst. Aerophys. TN* 17, 8 pp. + 13 figs., Oct. 1957.

A study of the effects of probe tip geometry and circular probe size on the laminar boundary layer of a hollow cylinder at a free-stream Mach number of 2.5 was made by means of total and static pressure surveys. In all, five circular probes, and one elliptical probe of tip width/tip height < 1, were investigated.

Approximately the same total pressure profile was obtained for all circular probes for which the ratio of tip height to apparent boundary-layer thickness was less than 0.29. This profile provided much closer agreement with theory than that measured with rectangular probes of conventional configuration, including those satisfying the above tip height criterion.

The total pressure profile, however, which approximated best the theoretical profile was obtained with an elliptical probe of tip-width to tip-height ratio equal to 0.69, and of tip-height to boundary-layer thickness less than 0.29. To throw light on this finding, static pressure measurements taken at the wall of the model during a total pressure probe traverse are presented for probes of comparable tip heights, one of rectangular, one of circular, and the third one of elliptical probe tip configuration. Least static pressure distortion was obtained with the use of the elliptical probe tip.

It was deduced that the boundary-layer distortion due to the presence of a total pressure probe in the boundary layer is a function of both its tip-width to tip-height ratio and its tip-height to boundary-layer-thickness ratio, and that the width of the probe tip is of primary importance. From author's summary

5058. Krzywoblocki, M. Z. v., On plane and spatial source in compressible flow (in English), *Bul. Istanbul tekn. Univ.* **10,** 2, 19–27, 1957.

Author treats the problem of a steady, irrotational, isentropic source or sink flow of an inviscid non-heat-conducting fluid. General equations for the velocity potential of a compressible plane and spatial source flow are derived. Approximate solutions of these equations are given for both an isentropic pressure-density relation and a simplified pressure-density relation of the form $p = C - Dp^{-1}$. Results are given for the flow in both the subsonic and supersonic regions. R. W. Detra, USA

5059. Oswatitsch, K., Influence of the local body shape upon the velocity distribution (in German), 9th Congrès intern. Mécan. appl., Univ. Bruxelles 1957; **8,** 430–438.

Theoretical new integral representation of linearized compressible equations is discussed with reference to local and distant influence of body shape. Velocity distributions over a Guderley profile and simple wedge are presented which compare favorably with previous methods. Effect of nose bluntness is also discussed. Author states that extension of method to trailing edges of wings will be forthcoming. W. Griffith, USA

5060. Stephenson, J. M., Note on matching a supersonic intake to an aircraft gas turbine, *J. roy. aero. Soc.* **62,** 567, 219–220 (Tech. Notes), Mar. 1958.

5061. Allen, H. J., Hypersonic flight and the re-entry problem (21st Wright Brothers Lecture), *J. aero. Sci.* **25,** 4, 217–229, Apr. 1958.

Paper reviews the possibilities and some of the main problems of three types of long-range vehicle, the ballistic, the glide, and the skip rocket. Performance assessments are made on the basis of an ingenious, if debatable, conversion of the vehicle characteristics to the Breguet formula. The problems of aerodynamic heating, aerodynamic loads and stability are briefly discussed, and other aspects of hypersonic flight—e.g., dissociation and ionization effects, and possibilities of free molecule flow—are touched upon. The results on the whole favor the glide vehicle for manned flight. The subsequent discussion on the paper includes references to multistaging and the use of high-energy fuels.

A. D. Young, England

5062. Linnell, R. D., Vertical re-entry into the earth's atmosphere for both light and heavy bodies, *Jet Propulsion* **28,** 5, 329–330, May 1958.

A solution for the velocity of a body during vertical re-entry into the earth's atmosphere is presented. A piecewise-exponential density, a piecewise-constant drag coefficient, and a constant acceleration of gravity are assumed. The solution involves use of a tabulated function of only a single variable.

From author's summary

5063. Van Dyke, M. D., A model of supersonic flow past blunt axisymmetric bodies, with application to Chester's solution, *J. Fluid Mech.* **3,** 5, 515–522, Feb. 1958.

Chester's solution [AMR **10** (1957), Rev. 3696] for supersonic flow past an axisymmetric blunt body suffers from poor convergence of the resulting series in $\delta = (\gamma - 1)/(\gamma + 1)$; convergence being satisfactory only for $\gamma < 1.2$, roughly. By considering the Taylor series expansion for the flow behind a parabolic shock, the present author arrives at a model for the Stokes stream function in terms of parabolic coordinates. The model, which is simply the first three terms of the series, gives good results even for $\gamma = 7/5$. It suggests recasting Chester's solution in parabolic coordinates also—with gratifying results for standoff distance and ratio of body to shock curvatures. The pressure result is not as good.

A corresponding attack on the plane flow case led the author nowhere. However, Chester's solution is more nearly adequate in this case.

S. H. Maslen, USA

5064. Sutton, G. W., The temperature history in a thick skin subjected to laminar heating during entry into the atmosphere, *Jet Propulsion* **28,** 1, 40–45, Jan. 1958.

Paper considers laminar convective heat transfer at stagnation point to a relatively thick heat sink entering the atmosphere along a constant-angle trajectory. One-dimensional heat conduction problem is solved in closed form by Green's function method. The maximum surface temperature in dimensionless form is expressed as a function of dimensionless grouping involving wall thickness, trajectory parameters, and thermal properties of heat sink. Detailed calculations are given for graphite, copper, molybdenum and tungsten. Reviewer notes that the assumption of a constant-angle trajectory, which disregards the gravitational force, yields accurate results for the heat flux for all entry angles greater than about two or three degrees with respect to the horizontal.

D. P. Chapman, USA

5065. Zienkiewicz, H. K., Flow about cones at very high speeds, *Aero. Quart.* **8,** 4, 384–394, Nov. 1957.

Effects of vibrational excitation and dissociation of air on inviscid hypersonic flow past a circular cone, at zero incidence, with an attached shock wave, are studied by numerical solutions, assuming that all changes of state take place at thermodynamic equilibrium. An approximate analytic solution is developed for the flow between the cone surface and the shock wave, considering that the shock wave lies near the cone surface. Numerical results are presented for a 30° semi-angle cone at Mach numbers of 7.860 and 16.62, with the free-stream condition of 218 K and 0.01 atmosphere, and compared with the corresponding solutions for constant air properties. A few remarks on the relaxation effects are included at the end of the paper.

F. Tamaki, Japan

5066. Waldron, H. F., An experimental investigation of the flow properties behind strong shock waves in nitrogen, *Univ. Toronto Inst. Aerophys. Rep.* 50, 25 pp. + 2 tables + 24 figs., Mar. 1958.

The flow properties behind strong shock waves in nitrogen were measured up to an incident shock Mach number of 13 and compared with calculated theoretical values. The shock-wave velocity, particle velocity, and speed of sound were measured from an $x - t$ schlieren record. The pressure was recorded simultaneously with an S. L. M. quartz crystal gage. A plane contact front travelling at the particle speed was produced by the interaction of the incident shock wave with a perforated steel plate. A weak spark was discharged in the uniform region between the incident shock wave and the contact front to produce a weak spherical wave from which the sound speed was obtained. From the measured values of shock wave and particle velocity, the pressure, density and enthalpy ratios were calculated. From the above-measured quantities and the theoretical values of the isentropic index the temperature ratio and flow Mach number were also calculated.

The directly measured quantities and the calculated values of pressure and enthalpy indicate fair agreement with theory; however, the other calculated properties indicate a fairly wide scatter which brackets the theoretical curves.

The attenuation of a shock wave over a distance of 18 feet from the diaphragm was investigated for a hydrogen-oxygen and a hydrogen-oxygen-helium mixture as a driver gas. Spark ignition at the closed end of the tube where a detonation wave was formed produced an attenuation of 3.2% of the incident shock Mach number per foot. A technique approximating constant volume burning was found to attenuate the shock wave at the rate of 1.3% per foot. Another form of burning the combustible gases in which the diaphragm rupturing process caused ignition resulted in an attenuation of 2.5% per foot. The attenuation of the shock wave when cold hydrogen was used was 0.8% per foot.

From author's summary

5067. Mathur, P. N., Diffraction of fluids by various shaped bodies (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **2,** 351–358.

This is a summary of results on the diffraction of plane waves caused by an elliptic cylinder. It contains an explicit expression of the exact wave function as an infinite series involving ordinary and modified Mathieu functions. The special cases of a plate of finite width and of a circular cylinder are considered. Some numerical results are illustrated by three graphs.

W. Noll, USA

5068. Sagomonian, A. Ya., The reflexion of a shock wave from the apex of a cone, and the problem of its penetration into a compressible fluid (in Russian), *Vestnik Mosk. in-ta* no. 3, 3–17, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2756.

The problem of the reflection (diffraction) of a shock wave from an infinite cone is reduced to the solution of an equation in partial derivatives of two independent variables. It is assumed that the velocity has a potential for which a quasi-linear, second-order equation applies.

The problems are first examined in the presence of nonlinear conditions. In this case, and using the method of characteristics, a small portion of the field of the flow behind the reflected wave is investigated in the vicinity of the line of intersection of the incident wave with the surface of the cone. No reference is made to the method of calculating the whole region behind the wave.

The problem is next examined in an acoustic approximation for weak waves. The solution in the hyperbolic region is sought by the method of characteristics. Some results of this calculation are presented. No calculations are made for an elliptical region.

For cones with an opening angle approaching π, approximate formulas are obtained for the velocity potential behind the reflected acoustic wave, over the whole region.

The problem of the penetration of an obtuse cone into a compressible fluid is examined in linear conditions. In this case,

making certain assumptions, the problem is found to be equivalent to that of the diffraction of a shock wave.

Some results are given of calculation referring to the case of a cone with a large apex angle. V. V. Rusanov

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Translation, courtesy Ministry of Supply, England

5069. Shamovskii, B. Ya., Determination of the resistance coefficient when gas suddenly expands (in Russian), *Trudi Novosibir. s-kh. in-ta* no. 9, 245–258, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 354.

Author proposes, when deriving the formulas for the determination of the resistance coefficient when a compressible gas suddenly expands, to proceed from the expression analogous to the expression for the resistance coefficient of a diaphragm when a compressible fluid is passed through it. This is an outcome of the author's previous work. In this expression the general coefficient of resistance (b_{gas}) of the diaphragm takes the aspect of two components: the coefficient of resistance of the orifice of the diaphragm to the passage of the gas ($b_{\text{orifice gas}}$) and the coefficient of resistance when the gas suddenly expands ($b_{\text{sudden expansion gas}}$). The value of ($b_g$) the author proposes to determine on the basis of the general equation of Bernouilli for compressible gas. Knowing the value of (b_g) from previous work by the author and determining ($b_{o.g.}$) on the basis of Bernouilli's equation it is possible to calculate the value of ($b_{s.e.g.}$). The derivation of formulas is given for the determination of the speed coefficient, consumption and coefficient of compression of the flows. It is shown that the speed coefficient for a compressible gas can be taken to be equal to the coefficient of an incompressible liquid. V. M. Akimov

Courtesy, Referativnyi Zhurnal, USSR
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Wave Motion in Fluids

(See also Revs. 4963, 4964, 4992, 5008, 5067, 5265)

5070. Wiegel, R. L., Snyder, C. M., and Williams, J. E., Water gravity waves generated by a moving low pressure area, *Trans. Amer. geophys. Un.* **39**, 2, 224–236, Apr. 1958.

Waves were generated by moving a pressure disturbance over water of constant depth h in a towing tank. When the disturbance moved at a speed below $(gh)^{1/2}$, certain results from Havelock's theory were confirmed. At speeds approaching $(gh)^{1/2}$, the wave pattern changed and consisted of one or more large waves, "solitary" in nature, followed by smaller waves. Comparison is made to surges observed on Atlantic coast when path of Hurricane Carol paralleled shoreline. Reviewer feels some reservation about this application because of shoaling water and shoreline boundary which are not modeled. R. S. Arthur, USA

5071. Draper, L., Attenuation of sea waves with depth, *Houille blanche* **12**, 6, 926–931, Dec. 1957.

Author describes an experimental comparison of surface waves with the pressure changes produced by them on the sea bed at a point fairly near to the beach. The attenuation of the waves is compared with that calculated by classical hydrodynamic theory. An empirical equation is evolved which agrees with these results. P. Franke, Germany

5072. Creco, L., Calci, P., and Visioli, F., Long period waves in a port (in French), *G. Gen. civ.* **95**, 11, 978–997, Nov. 1957.

Article gives the results of calculating the periods of uninodal and binodal oscillations in the ports of Trieste and Naples and compares the results with the observations of tide gages. The agreement obtained is good and some investigation is made of the generation of such oscillations during the passage of an intense meteorological depression. Specially large amplitude waves are obtained when the mean velocity of the depression is equal to the mean velocity of the water waves over the path of the storm. While the article contains much useful information about the experimental results, the theoretical background is not well explained. J. M. Jackson, Scotland

5073. Biesel, F., and Le Mehaute, B., Tri-dimensional seiche motion (in French), *Houille blanche* **12**, 3, 430–438, July/Aug. 1957.

Standing oscillations (seiches) in harbors, bays, or on the open coast may damage structures and ships. Knowledge of amplitude and period of such resonant systems, in partly enclosed waters, will help design efforts to minimize effects of forced oscillations created by incident waves. Most theory considers maximum disturbance caused by resonance of single standing wave system in partially enclosed bodies of water. Authors consider more complex boundaries which may result in unusual modes of oscillation in the enclosure and even multiple standing wave systems. Some aspects of such tri-dimensional seiche phenomena are the subject of this paper.

Resonant conditions are simply defined when the enclosure entrance is relatively small. For large enclosure entrances, a correction is necessary to establish a nodal line at or near the threshold of the enclosure such that the maximum disturbance coincides with resonant conditions. However, in nature the maximum disturbance may be caused by refraction or reflection due to the basin shape, and this disturbance may be quite different from resonant conditions.

Authors assume waves are linear combination of sinusoids and synthesize seiche motion on hypothesis: disturbance inside enclosure due to sum of wave components equals sum of disturbances due to individual components.

Most important features determining tri-dimensional seiche generation are found to be: (1) location of entrance with respect to geometry of enclosure, (2) relative size of entrance, (3) height, period and angle of incidence of incoming wave component, and (4) general topographic environment. Several cases are specified to illustrate relative dominance of each of these parameters in seiche production. W. Marks, USA

5074. Vilenskii, Ya. G., and Glukhovskii, B. Kh., Some regular features of waves caused by wind (in Russian), *Trudi Gos. okeanogr. in-ta* no. 29, 3–33, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1932.

Results are given for the investigations of the statistical features of wind waves, obtained from the study of numerous tabulated wave measurements in the inshore zone of the sea. The curves were examined and also the surfaces of the element distribution of the waves. The influence of the depth of the sea on the statistical characteristics of the wave elements is investigated. Some examples are given of the practical application of the deductions made. Yu. M. Krylov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5075. Sretenskii, L. N., Waves of finite amplitude, appearing as the result of periodically distributed pressure (in Russian), *Izv. Akad. Nauk SSSR, Otd. tekh. Nauk* no. 4, 505–511, 1953; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1929.

An original method is demonstrated for the approximate analysis of nonlinear waves. Let the complex potential have the form of

$$w = -cz + \frac{\gamma}{k} e^{-ikz} \qquad [1]$$

where c, γ, k are constants ($k > 0$). If ikz is defined as equal to ζ and τ to qt, where q is some parameter, then the trajectory equation can be recorded as

$$\frac{d\bar{\zeta}}{d\tau} = i\nu + \epsilon e^{\zeta} \quad \left(\nu = \frac{kc}{q}, \quad \epsilon = \frac{k\gamma}{q}\right) \qquad [2]$$

Assuming

$$\zeta = \zeta_0 + \epsilon\zeta_1 + \ldots, \qquad \nu = 1 + \epsilon\nu_1 + \ldots$$

it is found that

$$\zeta_0 = -i(\tau + \bar{\alpha})$$

where $\alpha = a + ib$, a constant integration. The numbers a and b are the essentials of Lagrange's variables, characterizing the original position of the particles. The expressions ζ_1, ζ_2, ... will contain persisting terms.

By arranging the values ν_1, ν_2, ... it is possible to make the coefficients with these items equal to 0. As the result, a parametric equation of the trajectory is obtained:

$$\zeta = -i(\tau + \bar{\alpha}) + \epsilon\left[ie^{i(\tau+\alpha)}\right] + \epsilon^2\left[\tfrac{1}{2}ie^{2i(\alpha-\bar{\alpha})}e^{-i(\tau+\alpha)}\right]$$

Terms in the order higher than ϵ^2 are discarded. Substituting thereupon

$$y = \frac{1}{2k}(\zeta + \bar{\zeta}), \qquad \left|\frac{dw}{dz}\right| = \frac{q^2}{k^2}\,\frac{d\zeta}{d\tau}\,\frac{d\bar{\zeta}}{d\tau}$$

in Bernoulli's integral, there is obtained

$$\frac{P}{\rho} = c + \frac{g\epsilon}{2k}i\left[1 - \tfrac{1}{2}\mu^2 - \frac{kc^2}{g\nu^2}\left(1 + \tfrac{1}{2}\mu^2\right)\right] \times$$

$$\left[e^{-i(\tau+\bar{\alpha})} - e^{i(\tau+\alpha)}\right] \qquad [3]$$

Here $\mu^2 = \nu - 1$. Formula [3] can be situated along any trajectory. This expression permits the examination, with the given accuracy, of various cases of the movement of a liquid. Recording a value for Lagrange's coordinate of $b = b_0$ and arranging the constants in such a way that

$$1 = \tfrac{1}{2}\mu^2 = \frac{kc^2}{g\nu^2}\left(1 - \tfrac{1}{2}\mu^2\right)$$

author obtains an approximate solution for the problem of the spreading of progressive waves and deduces Stokes's formula. In the last paragraph author applies formula [3] for the determination of steady running waves, appearing as the result of periodic distributed pressure. N. N. Moiseev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5076. Slavyanovich, V. Ya., The propagation of waves generated by disturbances in a deep basin on the surface of a shallow basin communicating with the former (in Russian), *Uch. zap. Tchkalovsk. ped. in-ta* no. 9, 55–105, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3079.

The Cauchy-Poisson problem is solved for the case of an ideal, incompressible fluid occupying two communicating basins, one of which has a finite depth h, and the other is of infinite depth. The following coordinate system is introduced: the x axis is directed along the undisturbed surface of the liquid, the y axis vertically upwards, dividing the deep and the shallow basins. The deep basin corresponds to the region I – $x < 0$, $-\infty < y < 0$; and the shallow basin to the region II – $x < 0$, $-h < y < 0$. The basins are divided by a solid wall on the section $-\infty < y < h$, $x = 0$, and communicate on the section $-h < y < 0$, $x = 0$. It is assumed that the initial disturbances take place in the deep basin, and that the depth h of the shallow basin is small compared with the length of the refracted waves propagated therein. Velocity potentials $\Phi(x, y, t)$ and $\varphi(x, t)$ are introduced. $\Phi(x, y, t)$ is a harmonic function for the region I, satisfying the wave condition

$$\lim_{y \geqslant 0}\left[\frac{\partial^2\Phi}{\partial t^2} + g\frac{\partial\Phi}{\partial y}\right] = 0$$

the condition of flow along a solid wall, and particular initial conditions. $\varphi(x, t)$ satisfies in region II the wave equation for zero initial conditions. It is also necessary to satisfy the equilibrium conditions for the rise in height of the liquid at the point $x = 0$, $y = 0$, and equality of the normal components of the velocity on the interface of the two basins:

$$\lim_{x\to-0}\left[\frac{\partial\Phi}{\partial x}\right]_{-h<y<0} = \lim_{x\to+0}\left[\frac{\partial\varphi}{\partial x}\right]_{-h<y<0} = \rho(t)$$

where $\rho(t)$ is a particular unknown function of t. The values of $\Phi(x, y, t)$ and $\varphi(x, t)$ are found, depending on $\rho(t)$.

From the condition of equality of the velocities along the interface between the basins, there is obtained for the determination of $\rho(t)$ a Volterra equation of the second kind with a difference nucleus possessing a logarithmic singularity. This equation is solved by methods of operational calculus and the solution is obtained in the form of a Riemann-Mellin integral. The complex nature of the subintegral function does not admit of a physically significant representation of the motion. In order to obtain an approximate solution for small values of t, a method of successive approximation is used, and Steklov's method of calculating determinate integrals. The singularity of the solution is demonstrated. A. M. Ter-Krikorov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5077. Rodionov, B. L., Laboratory investigations of the neutralization (damping) of waves by current and countercurrent flow (in Russian), *Trudi Leningr. in-ta inzh. vod. transp.*, no. 22, 166–172, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 581.

A description is given of a large glass trough, fitted with a wave-producing mechanism, in which there was arranged an even flow of water, with different water levels and a given discharge. In conformity with the theory of the pneumatic wave breaker, two sets of experiments were carried out: in the first, the influence of the countercurrent on the neutralization of the wave was investigated; in the second, of the current. The results of the experiments showed the influence of the stream velocity on the damping of the waves in a selected range of velocities. It follows from the results given that the largest neutralization of the waves is observed in countercurrent. Author indicates that the accuracy of the results is not outstanding. I. N. Kochina

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5078. Savarenskii, E. F., The "tidal wave" problem (in Russian), *Byl. Soveta po seismol. Akad. Nauk SSSR*, no. 2, 3–7, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 564.

General information is given regarding "tidal waves," the phenomenon of the formation of an unusually large wave, the height of which attains 30 m and more. Information is given of different cases of the formation of tidal waves and of their destructive effect. The periodicity of tidal waves is of the order of 10–30 min, the length of the wave of the order of 100 km, and velocity of propagation of the order 700 km/hr.

It is pointed out that tidal waves can traverse enormous distances without appreciable loss of intensity. Thus, for instance, when the Krakatoa volcano erupted, tidal waves were recorded in all the oceans of the globe. If a tidal wave happens to strike a river bed, then a wave is formed similar to a tidal bore, which

spreads up-stream and can have a large impact force. It is shown that not every underwater seismic disturbance is followed by tidal wave appearances. Seemingly, for its genesis, a considerable change in the contours of the seabed is essential. Some formulas are put forward for the calculation of tidal waves, but it is noted that their nature is conditional, as the impact force of these waves depends on the sea bottom contours and for other reasons. Various means of prognosis and information are discussed. N. N. Moiseev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Referativnyi Zhurnal

5079. Zarembo, L. K., The problem of the temperature dependence of the absorption of finite-amplitude waves in viscous liquids, *Soviet Phys.-Acoustics* **3**, 2, 173-174, Feb. 1958. [Translation of *Akust. Zh., Akad. Nauk SSSR* **3**, 2, 163-164, Apr.-June 1957, by Amer. Inst. Phys., Inc., New York, N. Y.]

At a frequency of 1.5 megacycles a thermoelectric receiver is used to perform measurements of the absorption coefficient of a finite-amplitude wave in transformer oil as a function of temperature (18.5-67.3°). Notwithstanding the 5-fold decrease of the shear viscosity in this temperature range, the absorption of a finite-amplitude wave increases. This can be qualitatively explained by the variation in the processes which distort the wave shape when the viscosity of the liquid varies.

From author's summary

5080. Skladnev, U. F., Surface-bottom regime in hydraulic jump, *Gidrotekh. Stroit.* **25**, 5, 41-46, May 1956.

5081. Bogdanov, G. G., Determination of the length of hydraulic jump (in Russian), *Gidrotekh Stroit.* **25**, 7, 51-53, July 1956.

Turbulence, Boundary Layer, etc.

(See also Revs. 5026, 5035, 5036, 5037, 5057, 5137, 5157, 5161, 5162, 5208)

5082. Varley, E., An approximate boundary-layer theory for semi-infinite cylinders of arbitrary cross-section, Brown Univ., Div. Appl. Math., AFOSR TN-58-53, 26 pp. + 1 fig., Jan. 1958.

Author is concerned with distribution of skin frictional force on the outside of a semi-infinite cylinder of arbitrary cross section moving steadily through a fluid parallel to its generators. Pohlhausen's approximate method is used, that is, finding a velocity distribution yielding zero viscous retarding force in the fluid (on the boundary-layer approximations). Method gives the expected square root growth of the boundary layer from the nose, with a close approximation to the coefficient. Results for the elliptic cylinder and finite flat plate are given in closed form with estimated maximum error 20%. Estimate is also made of the effect of corners, it being shown that only for re-entrant angles of 90% or less does the solution break down near the nose.

Reviewer considers the work to provide a definite advance toward the complete solution of the problem. Author's references to the work of Batchelor [AMR **8** (1955), Rev. 2075] are, however, misleading; Batchelor did not consider a semi-infinite cylinder but an infinite one, and did not suggest his results could be more than a guide to the solution in the semi-infinite case.

R. P. Pearce, Scotland

5083. Fraser, H. R., The turbulent boundary layer in a conical diffuser, *Proc. Amer. Soc. civ. Engrs.* **84,** HY3 (*J. Hydr. Div.*), Pap. 1684, 18 pp., June 1958.

The development of an axisymmetric boundary layer in a conical diffuser is analyzed and studied in continuation of the work of Uram, and Robertson and Holl. A simple, direct method for predicting the behavior of a turbulent boundary layer in a smooth-walled diffuser is proposed. The proposed method is based on the analysis of the boundary layer in two distinct regions as suggested by Ross and involves only the solution of algebraic equations. The experimental verification consisted of two tests conducted on a 10° total angle diffuser with different thicknesses of the initial boundary layer. The data from these tests are presented in tabular form and are used to test the applicability of the proposed method for boundary-layer calculations.

From author's summary

5084. Fediaevskii, K. K., and Ginevskii, A. S., A method for computing the turbulent boundary layer when a longitudinal pressure gradient is present (in Russian), *Soviet Phys.-Tecb.Phys.* **2**, 2, 275-291, Feb. 1958. [Translation of *Zh. tekb. Fiz. Akad. Nauk SSSR* **27**, 2, 309-326, Feb. 1957 by Amer. Inst. Phys., Inc., New York, N.Y.]

Authors develop an approximate method for computing the characteristics of the turbulent boundary layer using the momentum integral equation and semi-empirical turbulence theory. A simple expression for the velocity profile is obtained by integrating the Prandtl formula for the shear stress $\tau = \rho l^2 (\partial u/\partial y)^2$, where $l = \kappa y$ and $\tau^{1/2}$ is represented by a polynomial in y with coefficients determined from the exact differential equations evaluated at the wall and the outer edge. A skin-friction relation is obtained by assuming that the thickness of the viscous sublayer is given by $\delta_1 = \alpha(\nu/v_*)$, where α is another universal constant in addition to κ. Both α and κ are determined experimentally. On this basis, a simple and convenient method for computing the boundary-layer characteristics is developed. Examples of calculations for both two-dimensional and axisymmetric boundary layers are presented, and satisfactory agreement with experimental results is obtained. D. W. Dunn, Canada

5085. Alford, E. H., Temperature distribution studies in the turbulent boundary layer for compressible flow without heat transfer, Univ. of Texas, Defense Res. Lab., AFOSR TN-58-4, 33 pp. + 6 tables + 9 figs., Jan. 1958.

Paper presents an extension of Van Driest's theory of compressible turbulent boundary layer without heat transfer, taking into account the fact that the Prandtl number is not unity. Author's theory assumes that the local stagnation temperature in the boundary layer is expressed as a cubic expression of the mean velocity in the x direction, while Van Driest's theory implies that the stagnation temperature remains constant throughout the boundary layer. The third boundary condition is newly introduced on the hypothesis that either the ratio of the velocity at the point at which the local stagnation temperature equals the free-stream stagnation temperature to the free-stream velocity, $UA/U\infty$, or the corresponding Mach number ratio $MA/M\infty$ might be invariant with Reynolds number and Mach number based on free-stream condition. The velocity ratio $UA/U\infty$ is an important parameter in the modified theory.

Author's theory is applied to observed data of flat plate at Mach number of 2.00, 2.50, and 5.00. It is found that the parameter $UA/U\infty$ is independent of temperature recovery coefficient, free-stream Mach number, and plate Reynolds number, and is equal to 0.836 within the range of values investigated. The computed temperature profile agrees fairly well with the measured one. Reviewer appreciates this modified theory has made it possible to predict the temperature distribution in the compressible turbulent boundary layer for Prandtl number not being unity.

T. Okamoto, Japan

5086. Browning, A. C., Crane, J. F. W., and Monaghan, R. J., Measurements of the effect of surface cooling on boundary layer transition on a 15° cone: Part I. Tests at M = 2 and 3 in an 8" × 9" wind tunnel at R.A.E./Bedford, *Aero. Res. Counc. Lond. curr. Pap.* 381, 23 pp. + 1 table + 16 figs., 1958.

Tests on a steel cone of 15° included angle, cooled internally by the circulation of cold alcohol, gave the results that when the ratio (surface temperature ahead of transition)/(surface temperature for zero heat transfer) was reduced from 1.0 to 0.88, the transition Reynolds number at zero incidence was increased by a factor of about 1.8 for a local Mach number (M_1) of 1.86 and by a factor of 1.24 – 1.43 for $M_1 = 2.81$. The spread in the latter factor arose from alternative estimates of transition Reynolds number under zero heat-transfer conditions, since at $M_1 = 2.81$ this Reynolds number was dependent on stagnation pressure. (This effect might be explained by the presence of an adverse pressure gradient over the rear of the cone at this Mach number.)

Simultaneous records of transition position on the top and bottom generators of the cone were obtained in all cases, using the shadowgraph technique.

When the cone was set at an incidence of 2°, transition on the windward generator moved aft with cooling at about the same rate as was found in the zero incidence tests (at each Mach number). However, little, if any, movement could be discerned on the leeward generator.

Further tests at M = 3, 4 and 4.5 will be made at R.A.E./Farnborough. From authors' summary

5087. Morkovin, M. V., Transition from laminar to turbulent shear flow—A review of some recent advances in its understanding, *Trans. ASME* **80,** 5, 1121–1128, July 1958.

Recent experimental studies of transition from laminar to turbulent shear flows are reviewed. Certain common features are emphasized and related to the stability theories of viscous shear layers. The three-dimensional character, the unsteadiness, and the nonlinear and random behavior of the latter stages of the transition process are also examined.

From author's summary

5088. Stuart, J. T., On the non-linear mechanics of hydrodynamic stability, *J. Fluid Mech.* **4,** 1, 1–21, May 1958.

Author attacks the important and difficult problem of a nonlinear disturbance in a basic laminar flow by emphasizing the fundamental process of energy transfer. In particular he considers the distortion of the mean flow due to the effect of the Reynolds stress and its consequence on the rate of energy transfer. It is suggested that, in many cases, an equilibrium state may be possible in which this rate of transfer of energy from the distorted mean flow to the disturbance balances precisely the rate of viscous dissipation of the energy of disturbance. For flow between rotating cylinders, the theory yields a definite value for the torque required to maintain the motion beyond the critical Taylor number. Good agreement is obtained with G. I. Taylor's measurements of the torque for the case when the inner cylinder rotates and the outer cylinder is at rest. C. C. Lin, USA

5089. Deissler, R. G., and Loeffler, A. L., Jr., Analysis of turbulent flow and heat transfer on a flat plate at high Mach numbers with variable fluid properties, *NACA TN* 4262, 37 pp. + 24 figs., June 1958.

A previous analysis for flow in tubes [*NACA TN* 2629] is extended to a flat plate. The density, viscosity and thermal conductivity of the fluid are considered variable. After the evaluation of the empirical constants, satisfactory agreement with representative experimental results is obtained. Variation of skin friction and heat-transfer coefficients with Reynolds number is found to be considerable at high Mach numbers.

A. M. Kuethe, USA

5090. Chou, P.-Y., and Tsai, S.-T., Vortex motion and the vorticity structure of homogeneous isotropic turbulence in its final period of decay (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **3,** 257–268.

Velocity and vorticity distributions of vortices are derived by partially differentiating the corresponding functions of the spherical vortex with respect to the Cartesian coordinates. The axially symmetric case is investigated in detail. The structure of turbulence which is expressed by the double velocity correlation of the turbulent field is determined by the vorticity structure of the component eddies. Since the velocity and vorticity distributions are known, both the double and triple velocity correlations can be evaluated. The theory as developed here applies only to the final stage of turbulence. D. ter Haar, England

5091. Janssens, P., The role of correlations in a compressible fluid in homogeneous turbulence (in French), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **3,** 443–447.

Author discusses the 100 different averages obtained by considering products of two components of the energy-momentum tensor. For the case of homogeneous turbulence, these 100 quantities reduce to 19 independent scalars, and, for isotropic turbulence, to only two. Various relations between the scalars are discussed. D. ter Haar, England

5092. Chernov, L. A., Correlation of field fluctuations, *Soviet Phys.-Acoustics* **3,** 2, 203–206, Feb. 1958. [Translation of *Akust. Zh. Nauk SSSR* **3,** 2, 192–194, Apr.–June 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

Formulas are derived which establish the relationship between the correlation function for field fluctuations and the autocorrelation function for level and phase fluctuations.

From author's summary by D. ter Haar, England

5093. Favre, A. J., Gaviglio, J. J., and Dumas, R. J., Further space-time correlations of velocity in a turbulent boundary layer, *J. Fluid Mech.* **3,** 4, 344–356, Jan. 1958.

Paper describes the results of further measurements [see title source **2,** June 1957] of space-time correlations in the turbulent boundary layer of a flat plate. Hot-wire equipment is used, employing either one or two wires, and in the present work the movable wire is displaced from the fixed wire in a spanwise direction as well as along the stream and normal to the plate. Isocorrelation curves corresponding to optimum time delay are presented for separations in these three directions. The isocorrelation surfaces are much more extended along the stream than in either direction normal to the flow even at small distances from the wall. Additionally it is shown that: (1) The turbulence pattern tends to be convected along the stream from one position to a neighboring one with the mean local stream speed, while over longer distances the changes accompanying the evolution and renewal of turbulence are in evidence; (2) from comparisons of autocorrelation and longitudinal correlation, Taylor's hypothesis is a good approximation for distances from the wall greater than 6% of the boundary-layer thickness. These and other results throw considerable light on the behavior of eddy patterns in the turbulent boundary layer.

G. B. Schubauer, USA

5094. Heisenberg, W., On the statistical theory of turbulence, *NACA TM* 1431, 32 pp. + 4 figs., Jan. 1958.

Paper is a translation of "Zur statistischen Theorie der Turbulenz." The loss of turbulent energy with wave number between 0 and k consists of viscous loss $\mu \int_0^k E(y, t)\, y^2\, dy$ and a loss to small-scale motion which is assumed to be $\eta_k \int_0^k E(y, t)\, y^2\, dy$, where E is the energy spectrum of turbulence, μ the coefficient of

viscosity and μ_k the additional turbulent viscosity which must depend on wave numbers greater than k. From mainly dimensional arguments it is assumed that $\eta_k \sim \rho \int_k^\infty dy\,(E\,k^2)^{1/2}$. With these assumptions the equation governing E is determined and an approximate solution for E is given. More complete solution of the spectral equation is given by Chandrasekhar [*Proc. roy. Soc. Lond.* (*A*) **200,** p. 20]. The transformation between E and the commonly measured "one-dimensional" spectra is given. An expression for mean-square-pressure gradient is derived under the assumption that the fourth-order velocity correlations are related to those of second order as for a normal joint distribution of velocities.

Most of the material is now covered in "Theory of turbulence," Cambridge Press. M. S. Uberoi, USA

Aerodynamics of Flight; Wind Forces

(See also Revs. 4830, 4837, 4844, 4877, 4964, 5049, 5050, 5055, 5111, 5112, 5131)

5095. Klunker, E. B., and Harder, K. C., General solutions for flow past slender cambered wings with swept trailing edges and calculation of additional loading due to control surfaces, *NACA TN* 4242, 51 pp. + 4 figs., May 1958.

The slender-wing-type analysis is used to obtain general expressions for the surface pressure, lift, and rolling moment for cambered wings with swept trailing edges. These results are specialized to give the additional loading due to the deflection of trailing-edge control surfaces. The loading due to twist is also obtained for one particular form of twist.

From authors' summary by A. R. Mitchell, Scotland

5096. Mueller, J. N., Investigation of spoilers at a Mach number of 1.93 to determine the effects of height and chordwise location on the section aerodynamic characteristics of a two-dimensional wing, *NACA TN* 4180, 19 pp. + 19 figs., Feb. 1958.

The results of a pressure-distribution investigation of a 6-percent-thick symmetrical wing with spoilers are presented for a Reynolds number of approximately 1×10^6. The values of section normal force and pitching moment are presented as a function of angle of attack, spoiler height, and spoiler chordwise location. Some effects of spoiler height on spoiler pressure drag are shown for several angles of attack and two chordwise spoiler locations.

From author's summary

5097. Tanner, L. H., Curves suitable for families of aerofoils with variable maximum thickness position, nose radius, camber and nose droop, *Aero. Res. Counc. Lond. curr. Pap.* 358, 15 pp. + 15 figs., 1957.

Paper shows that it is possible to design geometric curves, given by single explicit equations, and having shapes suitable for use as airfoil sections. A family of sharp-nosed sections with variable maximum thickness position is described. A method of rounding the leading edge of any sharp-nosed section is then suggested. Finally, a family of curves with camber and nose droop is given. The methods used could be adapted to produce other section variations if required.

From author's summary by J. M. Hedgepeth, USA

5098. Couchet, G., Motion of an airfoil in the presence of a wall (in French), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **2,** 551–567.

Since the problem of a moving airfoil in the presence of walls has not been solved in an exact manner except in the special case where the wall is plane and the airfoil reduces to a straight line segment, present paper considers an airfoil of any shape in the presence of any arbitrary obstacle. The investigation of the potential shows that the theoretical solution is no more complicated for an airfoil of arbitrary shape than it is for a segment of a straight line and can easily be adapted to the case of several walls and even of several airfoils.

The following problems are specifically treated in the paper: Investigation of the potential for any profile in the presence of an obstacle; case of the rectilinear obstacle; study of an approximate potential; aerodynamic forces in the case of the plane wall; uniform translation, parallel to the wall, of a sharp-pointed airfoil; treatment of the special case of a plate and comparison with other results. S. Ostrach, USA

5099. Van Dyke, M. D., Second-order subsonic airfoil theory including edge effects, *NACA Rep.* 1274, 23 pp., 1956.

Several recent advances in plane subsonic flow theory are combined into a unified second-order theory for airfoil sections of arbitrary shape. The solution is reached in three steps: The incompressible result is found by integration; it is converted into the corresponding subsonic compressible result by means of the second-order compressibility rule; and it is rendered uniformly valid near stagnation points by further rules. Solutions for a number of airfoils are given and are compared with the results of other theories and of experiment. A straightforward computing scheme is outlined for calculating the surface velocities and pressures on any airfoil at any angle of attack.

From author's summary by J. S. Holdhusen, USA

5100. Heyson, H. H., and Katzoff, S., Induced velocities near a lifting rotor with nonuniform disk loading, *NACA Rep.* 1319, 47 pp. + 69 figs., 1957.

A theoretical and experimental investigation of the induced velocities near a lifting rotor has been conducted. The results are presented in three parts.

Part I presents a method for computing, from available calculations for uniform disk loading, the effect of nonuniform circularly symmetrical disk loading on the normal component of induced velocity in the vicinity of a lifting rotor. Charts of the normal component of induced velocity are given for the longitudinal plane of symmetry and for the major axes of rotors with two different, nonuniform circularly symmetrical disk-load distributions. It is shown that the normal component of induced velocity must be zero at the center of any practical rotor. A comparison of the results of this report with those for a uniform disk loading shows that nonuniform disk loading has a powerful effect on the induced velocity distribution and that it must be taken into account in estimating the effect of the rotor on most components of an aircraft.

Part II develops certain symmetry relations for the induced velocities in the plane of a uniformly loaded rotor and also develops relations between the radial load distribution of the rotor and the radial variation of induced velocities in the wake.

Part III presents the results of an investigation in the Langley full-scale tunnel of the induced flow near a lifting rotor. Measurements of stream angles and velocities were made in several transverse planes along and behind the rotor in four different conditions representative of the cruising and high-speed ranges of flight. These measurements indicate that available theory may be used to calculate with reasonable accuracy the induced flow over the forward three-quarters of the disk for these flight conditions provided that a realistic nonuniform rotor disk-load distribution is assumed. Rearward of the three-quarter-diameter point, calculations of the induced velocity are increasingly inaccurate due to the rolling up of the trailing-vortex system. Farther rearward, well behind the rotor, the flow may be represented more accurately by the flow behind a uniformly loaded wing.

From authors' summary

5101. Gerathewohl, S. J., Ritter, O. L., and Stallings, H. D., Jr., Producing the weightless state in jet aircraft (in English), *Astronaut. Acta* **4**, 1, 15–24, 1958.

Simple functions were used for computing the most interesting and important characteristics of the parabolic flights. The results, based upon certain flying characteristics of the T-33, F-94C, and F-104 in subsonic and transsonic flight, are in good agreement with the data obtained for the first two aircraft types during actual zero-gravity maneuvers. Certain flying safety hazards were noticed in the T-33 but were remedied through appropriate measures. The F-94C Starfire proved to be superior to the T-33 with regard to safety and duration of the weightless state. If the F-104 would be made available for aeromedical research, weightlessness could be produced for more than one minute.

From authors' summary

5102. Markham, B. G., Getting a civil turboprop into service, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-132, 10 pp.

5103. Stepniewski, W. Z., Tilt wing aircraft in comparison with other VTOL and STOL systems, *J. Helicop. Assn.* **11**, 6, 299–339, Dec. 1957.

5104. Pocock, P. J., and Bowker, A. J., VTOL transport aircraft: a brief discussion of Canadian requirements and project study results for tilting-wing configurations with two propellers and four propellers, *Nat. aero. Establ. Canad. LR* 204, 18 pp. + 24 figs., Sept. 1957.

5105. Price, E., and Westerwick, R., Analysis of an electrical flight-control system for interceptor-type aircraft, *Aero. Engng. Rev.* **16**, 8, 63–67, 77, Aug. 1957.

5106. Zbrozek, J. K., Gust alleviation factor. I. Incompressible flow. II. Compressibility effect. III. Gust loads on swept wings, *Aero. Res. Counc. Lond. Rep. Mem.* 2970, 50 pp., 1958.

Paper reports calculations by strip theory, considering vertical motion of rigid aircraft. Results demonstrate that value of gust-alleviation factor is largely influenced by gust shape and that it decreases appreciably with increasing subsonic Mach number.

S. B. Berndt, Sweden

Aeroelasticity (Flutter, Divergence, etc.)

5107. Proceedings, Aeroelastics colloquium (in German), Gottingen, April 16–17, 1957; *Mitt. Max-Planck-Inst. Stromungsforschung* no. 8, 180 pp., 1958.

The proceedings of the Aeroelastic Colloquium in Gottingen contains seven papers and accompanying discussions. The colloquium was held under the direction of Professors Betz and Küssner of the Aerodynamic Research Laboratory of Gottingen.

The introductory paper by Küssner contains an outstanding summary of methods of solving aeroelastic problems for plate-like wings and for the entire airplane. Both the structural and aerodynamic ingredients of the problem are discussed, although somewhat more space is devoted to the former.

A paper by A. I. van de Vooren discusses flutter calculations of modern aircraft with many degrees of freedom. Mode shapes of the airplane without forward speed are employed as degrees of freedom and a method is presented for eliminating the fuselage degrees of freedom. Iteration methods are discussed and the use of electronic computers is suggested.

A paper by de Vries discusses the use of mode shapes in a vacuo in flutter calculations, and another by Gruschwitz concerns flutter calculations involving rudders with servo systems.

Two papers are devoted to laboratory methods of obtaining unsteady aerodynamic forces. The first by Bergh deals with oscillating two-dimensional flapped-surfaces in a wind tunnel. The second by Merbt and Hansson presents a potential tank method of obtaining two- and three-dimensional unsteady incompressible forces and moments on oscillating wings.

A final paper by Schoen describes the determination of ground mode shapes and frequencies of a 1000 kg sailplane using electronic measuring equipment.

For all papers, the discussion following presentation was lively and this is well documented in the proceedings.

R. L. Bisplinghoff, USA

5108. Minhinnick, I. T., and Woodcock, D. L., Tables of aerodynamic flutter derivatives for thin wings and control surfaces in two-dimensional supersonic flow, *Aero. Res. Counc. Lond. curr. Pap.* 382, 14 pp. + 9 tables + 8 figs., 1958.

Report gives tables of the two-dimensional supersonic flutter derivatives for infinitesimally thin airfoils. Most of the values given are based on the published work of several authors but some have been specially calculated for this report. Only the derivatives giving the forces on wings and control surfaces due to wing motion are tabulated but it is shown how the remaining derivatives can be very easily obtained from those tabulated. The values tabulated are for control surface/wing chord ratios of 0(0.1) 0.6, 1.0; for Mach numbers (M) given by $\lambda (= 1/M) = 0.3(0.1)\ 0.8$, and for at least 11 values of the frequency parameter between 0 and 1.5.

From authors' summary

5109. Lambourne, N. C., and Scruton, C., On flutter testing in high-speed wind tunnels, *Aero. Res. Counc. Lond. Rep. Mem.* 3054, 14 pp. + 1 table + 15 figs., 1958.

The requirements for simulating in a wind tunnel flutter conditions appropriate to high-speed flight are discussed, and an assessment is made of the desirable features of a wind tunnel suitable for flutter testing at transonic and supersonic speeds.

It is concluded that such a tunnel should have either the Mach number or the stagnation pressure variable during the tunnel run, and that it is of considerable advantage, and for some purposes essential, for high stagnation pressures to be available. The stagnation pressure required to allow flight conditions to be simulated with a flutter model is considered to range from at least 2 atmospheres for transonic speeds to about 15 atmospheres for $M = 4$. No attempt to simulate kinetic heating is envisaged, although its effect on stiffness should be allowed for in the design of the model. To minimize uncertainties due to the variation of the model stiffness with temperature it is desirable that means for controlling the stagnation temperature should be incorporated in the tunnel.

From authors' summary

5110. Eckhaus, W., Asymptotic solution of the two-dimensional oscillating aerofoil problem for high subsonic Mach numbers (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **3**, 145–151.

Writer attacks the linearized problem of a two-dimensional oscillating airfoil in compressible subsonic flow up to $M = 1$ and for high values of the reduced frequency. He shows that the previous method of Burger can be simplified. The new method is more straightforward and fits better to physical explanation. The technique is as follows: The solution of the Helmholtz wave equation (to which the problem is reduced) is presented as an integral. The integrand itself is represented by means of an integral equation of the Abel type, which is solved by an iteration process. This inserted into the previous integral gives the final solution in the form of an infinite series related to Green's function of the second kind for the problem. Engineering benefits of this approach are obvious.

M. Z. v.Krzywoblocki, USA

5111. Molyneux, W. G., The determination of aerodynamic coefficients from flutter test data, *Aero. Res. Counc. Lond. curr. Pap.* 347, 11 pp. + 1 fig., 1957.

Report gives method of determining the complete set of oscillatory aerodynamic coefficients for a wing without using excitation equipment. A rigid wing is allowed to flutter (with two degrees of freedom) and the critical velocity and frequency are determined for two modes of oscillation (e.g. pitch about two axes). From this data, together with the structural coefficients of inertia, damping and stiffness, the aerodynamic coefficients can be obtained.

Results of preliminary test give rather poor agreement with calculated values. Technique is being developed to give improved accuracy. A. W. Babister, Scotland

5112. Bonney, E. A., and Fuess, B. F., Aeroelastic effects on aerodynamic trim and hinge moment characteristics of supersonic controllable missile configurations (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **2**, 186–198.

Method of linearizing steady-state aeroelastic effects on normal force and pitching moment derivatives is briefly described. Equations are listed for wing control, tail control, and canard missile configurations.

Very general conclusions based on application of such equations, but no numerical or graphical results, are presented. Body deflections may affect aerodynamic trim conditions, especially under high dynamic pressure conditions. Location of support point for fixed surfaces is significant. Structural strength and aerodynamic gain for movable surfaces are significantly affected by aeroelastic conditions. E. T. Welmers, USA

5113. Hall, H., and Chapple, E. W., A comparison of the measured and predicted flutter characteristics of a series of delta wings of different aspect ratios, *Aero. Res. Counc. Lond. Rep. Mem.* 3071, 4 pp. + 1 table + 4 figs., 1958.

5114. Miles, J. W., On a reciprocity condition for supersonic flutter, *J. aero. Sci.* **24**, 12, p. 920 (Readers' Forum), Dec. 1957.

5115. Templeton, H., A review of the present position on flutter, *AGARD Rep.* 57, 16 pp., Apr. 1956.

Propellers, Fans, Turbines, Pumps, etc.

(See also Revs. 4839, 5032, 5033, 5042, 5061, 5146, 5263, 5274)

5116. Speidel, L., and Scholz, N., Investigations into the flow losses of cascades (in German), *VDI-Forschungsheft* no. 464, 36 pp., 1957.

In the hydrodynamics of vane systems the two-dimensional flow through cascades is a problem which can readily be solved mathematically. It is by far more difficult to solve this problem by *experiments* since, due to the viscosity of the fluid, phenomena occur (influence of walls, secondary flows) which affect more or less the two-dimensional character of the flow around the cascade. This publication deals with the results of both mathematical studies and thorough tests which have been conducted in the Institute of Hydraulic Flow Research of the Technical High-school of Braunschweig (Germany). Cascades with vanes of the profiles NACA-0010 and NACA-8410 have been investigated for the four ratios of vane overlap $\frac{t}{l} = 0.50; 0.75; 1.00$, and 1.25 and the five vane angle values $\beta s = 30°, 60°, 90°, 120°$, and 150°

The hydrodynamic characteristic curves of the cascades in question have been calculated for friction-free flows and subsequently corrected with due consideration of the form and the behavior (separation) of the boundary layer. A comparison of the measured values with the computed polar diagrams of the cascades and of the angles of down-wash reveals a satisfactory agreement between calculation and measurement, provided that the boundary-layer separation in the rear edge range remains within certain limits. This agreement may be slightly improved by a more accurate calculation method, say by shifting the singularities from the cord of profile to the mean line of the vane.

The characteristic curves of the cascades allow a ready selection of a cascade arrangement for which the flow losses are a minimum. M. Strscheletzky, Germany

5117. Lown, H., and Wiesner, F. J., Jr., Prediction of choking flow in centrifugal impellers, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-15. 7 pp.

Expressions for the choking flow rate for inducer type and purely centrifugal impellers are found analytically, assuming (1) two-dimensional flow in the sense that properties do not vary from blade to blade; (2) choking occurs at the narrowest geometrical cross section.

The boundary-layer displacement thickness and the inaccuracy of the assumptions are taken care of by a factor found from experiments with four different impellers and various gases, and plotted versus angle of incidence. This factor appears to be independent of the impeller design and therefore useful.

H. P. Eichenberger, USA

5118. Sovran, G., The measured and visualized behavior of rotating stall in an axial-flow compressor and in a two-dimensional cascade, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-20, 11 pp.

The technique of smoke-flow visualization has been used to show clearly the action of the flow field upstream of a single rotor during rotating stall. The flow processes on the blades and in the blade passages of a stationary compressor cascade also have been observed, using the same technique. An audio method of detecting rotating-stall patterns has been developed and has indicated that some compressor operating conditions at which no periodic flow disturbance was previously thought to occur actually contained rotating-stall patterns whose number of stalled regions changed very quickly from one value to another. The absolute speed of rotation of a stall zone was reduced to zero and its overall shape clearly outlined by means of smoke visualization. The qualitative results of all these investigations have given a good physical picture of the rotating-stall phenomenon. Severe reverse flows were found to exist during rotating stall, and these caused the formation of reversed flow regions extending upstream of a blade row. Furthermore, the distortions of the flow field in the vicinity of a blade row were found to be of such large magnitude that it does not seem likely that they can be described adequately by any linearized theory. Quantitative investigations were made into the effects of guide-vane turning and axial position on the rotating-stall characteristics of an axial-flow-compressor rotor. The absolute direction of the fluid entering such a configuration was found to affect nearly all facets of rotating-stall behavior.

From author's summary

5119. Watkins, J., Stage performance and radial matching of axial compressor blade rows, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-21, 11 pp.

To obtain the ultimate in performance from an axial compressor stage it is necessary that the operation of the blade rows comprising the stage be thoroughly understood. Appreciable advances have been accomplished in recent years, but much still remains to be done. This paper aims to present practical hypotheses concerning the nature of the flow between the blades, and deals with design techniques in relation to this flow.

In addition, some elements of two-dimensional cascade data and a discourse on practical secondary flows are presented.

From author's summary

5120. Turner, R. C., Ritchie, J., and Moss, C. E., The effect of inlet circumferential maldistribution on an axial compressor stage, *Aero. Res. Counc. Lond. Rep. Mem.* 3066, 8 pp. + 15 figs., 1957.

Report describes tests on a single compressor stage with circumferentially nonuniform inlet conditions. The stage was a model of the first stage of a typical modern aircraft-engine compressor, and the tests were planned as part of an investigation into the surge behavior of compressors with inlet flow maldistribution.

It was found that with a roughly rectangular inlet velocity distribution of amplitude ±25% of the mean value, the surge flow instead of showing an expected increase was almost unchanged, being in fact slightly reduced. The efficiency fell greatly, with an accompanying small drop in temperature-rise coefficient. The velocity profile was distorted and its amplitude greatly decreased at the outlet of the stage.

These results are important in that they suggest that the surge of the first stage is not the primary factor in determining the surge of a multi-stage compressor. It would appear that the primary effect of maldistribution is to decrease the efficiency of the first stage or stages, and thus alter the stage matching at the surge flow, which is, however mainly determined by the later stages. The maldistribution will probably have disappeared at these later stages, which will thus exhibit their normal characteristics. These conclusions are supported by analysis of multi-stage compressor performance and by theoretical considerations.

From authors' summary

5121. Uvarov, V. V., The suction part of a centrifugal compressor and its calculation (in Russian), *Sb. statey Mosk. Vyssh. tekhn. uch.-shcha* **39,** 15–42, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2937.

The flow in the suction part of a centrifugal compressor is schematically represented by a potential flow of an incompressible fluid produced by two vortex trains: one, annular, with its axis on the rotor axis, the plane whereof is perpendicular to that axis, and one rectilinear of infinite length, combining with the axis of the rotor. The combination of such flows may give a great variety of forms of the suction header and satisfy a wide range of design requirements. The conditions are examined for minimum suction losses. Tables and diagrams facilitating calculation are appended. V. I. Vasil'ev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5122. Klyachko, L. S., The maximum and relative efficiencies of low-pressure centrifugal machines, and a description of a new method for calculating such machines (in Russian), *Trudi nauch. sessiyi Vses. n.-i. in-ta okhrany truda* no. 1, 93–137, 1954 (1955); *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2939.

Some relationships are presented for determining the geometric proportions of a fan, insuring its working under optimum conditions. S. A. Douzhik

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5123. Sterrett, J. R., Experimental investigation of an impulse-type supersonic compressor rotor having a turning of 73° at the mean radius, *NACA TN* 4252, 15 pp. + 2 tables + 18 figs., June 1958.

An impulse rotor with guide vanes was designed and tested in Freon-12. The rotor had an inlet and exit hub-tip ratio of 0.575 and 0.75, respectively. The blade-passage design was based on a two-dimensional vortex-flow theory modified to account partially for three-dimensional compressions. The rotor achieved an over-all pressure ratio of 7.2 near design speed with an equivalent weight flow of 28.6 lb/sec of air per square foot of frontal area.

From author's summary

5124. Grant, W. L., and de Villiers, R. C., The performance characteristics of a pump-actuated hydraulic air compressor, *So. African mech. Engng.* **7,** 10, 299–324, May 1958.

Paper describes the component and over-all performance characteristics of an hydraulic air compressor operating on a recirculating water system employing an internal gear-type pump as the driving unit. Air is drawn into water-jet injectors where the fluids are mixed and diffused and then delivered by the gear pump into the receiver, where the air and water separate. The air is drawn off as compressed air and the water is re-used in the injectors. The analysis of the cycle shows that the efficiency can be expressed as $\eta_c = \eta_p + (1 - \eta_v)(E_o/\epsilon)$ where η_c, η_p and η_v are the compressor, pump and injector efficiencies respectively, and E_o/ϵ is the ratio of the kinetic power in the water jets to the power input to the pump. Tests were run with different nozzle-venturi combinations in the injectors with each of two pump delivery rates. It was found that, for a given ratio of nozzle to venturi throat area, the injector efficiency was primarily a function of the ratio of the pressure rise in the venturis to the pressure drop across the water nozzles. The pump efficiency was found to be primarily a function of E_o/ϵ, and an empirical equation was established relating the two factors. This equation was used in an analysis underlying the matching of the pumps and injectors, the analysis showing the importance of having the components properly matched if high over-all efficiences are to be attained. The effect of improvements in the components on the over-all efficiency is discussed. In general, it appears that such a machine holds promise as a unit for yielding high pressures in a single stage. From authors' summary

5125. Moffitt, T. P., Maximum theoretical tangential velocity component possible from straight-back converging and converging-diverging stators at supercritical pressure ratios, *NACA TN* 4271, 11 pp. + 10 figs., Apr. 1958.

The results of the investigation show that converging stators are limited to exit tangential components of critical velocity ratios less than 1.714, while values up to the theoretical limit of 2.449 (corresponding to a Mach number of infinity) might be realized from converging-diverging stators. Unless design requirements are rigorous or unless extremely small blade exit angles as measured from the tangential are to be used, an approximate method of assuming uniform flow at the stator exit appears adequate in determining the maximum tangential velocity component possible from stators. From author's summary

5126. Kviatkovskii, V. S., Two new types of reaction turbines with adjustable blades (in Russian), *Gidrotekh. Stroit.* **26,** 11, 62–67, Nov. 1957.

5127. Nazarchuk, M. M., Analytical method of calculating the stages of a gas turbine of variable cycles at subcritical flow velocities (in Russian), *Sb. tr. in-ta teploenerg. Akad. Nauk USSR*, no. 12, 59–68, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1792.

An approximate analytical method is demonstrated for the thermal calculation for the stage of a gas turbine at given dimensions for the section of the turbine between the inlet and outlet valves and at subcritical flow velocities. When composing the characteristics of turbines of variable cycles, a basic difficulty is found to be the correct selection of losses; the author

does not go into this question, only mentioning the fact that the velocity of coefficient Ψ should be selected while taking into account the loss due to impact. V. Kh. Abrants

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5128. Panteleev, N. I., Determination of leakage of steam in a turbine through surface (external) condensation (in Russian), *Trudi Leningr. Korablestroit. in-ta* no. 15, 146–151, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1738.

Formulas are deduced for the determination of the leakage of steam from labyrinth condensation of a steam turbine, taking into account the heat elimination from the steam to the drum. The calculation following the author's method shows that the cooling of the steam, causing an increase of its specific weight, leads to an increase in the loss of 10–12% by comparison with the loss calculated by Stodol's formulas, without regard to the influence of the cooling of the steam. G. A. Varshavskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5129. Tabachnikov, L. Ya., Problem of investigation of the fluctuations of pressure in the outlet equipment of two-cycle engines fitted with gas turbine on the end (in Russian), *Trudi Tallinsk. politekhn. in-ta, A,* no. 47, 17–45, 1953; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1820.

An approximate method is given for the determination of the amplitude and phases of the fluctuations of pressure in any place in the outlet conduit system with a gas turbine at the end (taking into account the compressibility of the gases). Basing his investigation on work previously carried out, author substitutes for the gas turbine an equivalent diaphragm and takes into account the resistance of the diaphragm only, disregarding the other low resistances of the conduit. V. I. Kirsanov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5130. Dzidziguri, A. A., "Critical" number of revolutions of ventilators during parallel working (in Russian), *Trudi in-ta metalla i gorn. dela Akad. Nauk Gruz. SSR* **7**, 251–260, 1956; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1781.

5131. Castles, W., Jr., Durham, H. L., Jr., and Kevorkian, J., Normal component of induced velocity for entire field of a uniformly loaded lifting rotor with highly swept wake as determined by electromagnetic analog, *NACA TN* 4238, 12 pp. + 2 tables + 8 figs., June 1958.

Values of the normal component of induced velocity throughout the entire field of a uniformly loaded rotor at high speed are presented in the form of charts and tables. Many points were found by an electromagnetic analog, details of which are given. Comparisons of computed and analog values for the induced velocity indicate that the latter are sufficiently accurate for engineering purposes.

From authors' summary

5132. Ludl, L. H., Flight investigation of effects of retreating-blade stall on bending and torsional moments encountered by a helicopter rotor blade, *NACA TN* 4254, 9 pp. + 9 figs., May 1958.

The results of the investigation indicate that blade stall can produce large increases in periodic blade moments during high-speed flight and pull-up maneuvers. The results also indicate that the higher harmonics can contribute as much as the lower harmonics to increased vibration and increased periodic control loads in the highly stalled condition.

From author's summary

Flow and Flight Test Techniques

(See Revs. 5016, 5208, 5214, 5240, 5251)

Thermodynamics

(See also Revs. 5027, 5128, 5225)

Book—5133. Rogers, G. F. C., and Mayhew, Y. R., Engineering thermodynamics: work and heat transfer, New York, Longmans, Green & Co., 1957, x + 619 pp.

Book is composed of four parts: Part I, principles of thermodynamics; Part II, applications to particular fluids; Part III, work transfer; Part IV, heat transfer; good problems (some answers); and references. Wording is unusually precise and concise, with size of book due to extensive content, not wordiness. Good balance of principle and application make book both a text and reference. First portion of chapters is suited to introductory courses in thermodynamics, heat power, and heat transfer, remainder for the more serious student and practitioner. Wide scope suggests use as single text in several related courses.

Reviewer was impressed by careful use of thermodynamic boundaries and mathematical distinctions except for the use of Q_1 and Q_2 in chapters 5 and 6, which is needlessly confusing particularly in view of the specific caution against such use on p. 12. Some symbols differ from American standards, but not seriously. Lack of distinction between lb_m and lb_f is regrettable for introductory use. Occasional application of "only," etc., to the verb when the limitation is actually on the subject or object could be misleading to the attentive novice. Reviewer questions desirability of developing first a highly special case (non-flow), then another special case (steady-flow), and finally merely a limited form of what might otherwise be a general case (nonsteady-flow). Authors carefully point out practical limitations of developed principles and use mechanical devices merely as examples of thermodynamic application.

Reviewer recommends this book as possible multiple text and as good up-to-date reference for practicing engineers.

J. Scanlan, USA

5134. Vaisman, M. D., Thermodynamical bonds in an irreversible adiabatic flow of saturated steam (vapor) (in Russian), *Trudi Leningr. politekhn. in-ta* no. 2, 192–204, 1953; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1737.

Introducing into the investigation "the coefficient of loss of kinetic energy" (in case of retarded flow), author deduces, in an hydraulic arrangement, different correlations, enabling him to give a thermodynamic description of a one-dimensional steady flow of saturated steam (vapor). S. S. Grigoryan

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5135. Horlock, J. H., The thermodynamic efficiency of the Field cycle, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-44, 14 pp.

Paper contains an analysis of the thermodynamics of the Field cycle and its several modifications, but does not attempt to discuss the practicability of the cycle. The effects of internal and external irreversibilities on over-all efficiency are considered. The efficiency of the practical Field cycle is shown to be equal to the sum of the basic Joule-Brayton cycle efficiencies less the product of these efficiencies. It is found that there is an optimum pressure ratio in the Joule-Brayton part of the cycle for maximum over-all efficiency, if maximum pressure and temperature and condenser pressure are fixed. From author's summary

5136. Salisbury, J. K., Analysis of the steam-turbine reheat cycle, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-186, 9 pp.

5137. Jarre, G., Velocity of dissociation of a diatomic gas (in Italian), *Monogr. Lab. Aero. Politecn. Torino* (8) **13,** 3/4, 125–133, Sept./Oct. 1957.

5138. Meleso, G. B., Thermodynamics of gas-cooled reactors, *Nucleonics* **16,** 2, 72–76, Feb. 1958.

The ratio of net electrical power P_{ec} obtainable from an unreflected cosine-distributed nuclear reactor channel to its total thermal power P_{tc} is obtained as a function of the maximum permissible fuel element surface temperature t_{max} and the average coolant gas absolute temperature θ_{avg} in the channel, besides the pertinent coolant physical properties and geometrical and thermodynamic factors, including the fictitious sink absolute temperature θ_a at which the steam cycle efficiency extrapolates linearly to zero (about 330 K).

By partial differentiation, the optimum θ_{avg} is the geometric mean of t_{max} and θ_a, and the pumping power P_p is half of the net electrical power. This is an impractical operating point, but is useful for defining θ_{avg}, P_{tc}, P_{ec}, and P_p dimensionlessly. A parametric plot of these dimensionless variables is given. Practical power is near $P_{ec} = 11\ P_p$, shown on the plot. If the flow per channel is regulated with nozzles to the same outlet temperature, the plot is applicable to the whole reactor. The plot is useful in design, and in the comparison of operating points of gas-cooled reactors. C. F. Bonilla, Puerto Rico

5139. Crocco, L., Glassman, I., and Smith, I. E., A flow reactor for high temperature reaction kinetics, *Jet Propulsion* **27,** 12, 1266–1267, Dec. 1957.

Authors report on design of a mixing nozzle and on flow system for a flow reactor. Reagent is mixed with hot inert gas, giving mixing and heating time of only 0.5 to 3 millisecs.

Rate of reaction is determined by following temperature changes, thus unfortunately limiting application to those systems in which there is a simple direct relation between the extent of reaction and heat evolved or absorbed. R. C. Anderson, USA

5140. Hoge, H. J., Eichacker, Suzanne S., and Fiske, D. L., Studies of jet compression—I, Apparatus and methods. Results with air at room temperature, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-13, 7 pp.

An experimental jet compressor (ejector) employing gases at subatmospheric pressures is described and data are presented showing efficiencies obtained with air used as both the driving and the driven fluid. A technique is described by means of which efficiency may be determined as a function of outlet pressure and entrainment ratio. Curves are presented showing that efficiency passes through a maximum as outlet pressure is increased. The compression ratio of the driven fluid likewise passes through a maximum as the outlet pressure is increased, but the maximum of efficiency occurs at a slightly higher pressure than the maximum of compression ratio. The highest efficiency achieved was 20.6 per cent, at an entrainment ratio of 1.3 and a compression ratio of 1.14. The ratio of pressure of driven stream to pressure of driving stream at time of contact has been determined. The value of this pressure ratio corresponding to maximum efficiency was found to increase linearly with entrainment ratio, over most of the range of the measurements. From authors' summary

5141. Mizrahi, J., Solomiansky, M., Zisner, T., and Resnick, W., Ejector refrigeration from low temperature energy sources, *Bull. Res. Counc. Israel* **6C,** 1, 1–8, Nov. 1957.

Calculations have been carried out to determine the feasibility of operating an ejector refrigeration system with a low-temperature energy source such as that available from simple solar collectors, or exhaust steam. The calculations were based on data previously reported for a commercial ejector. With an evaporator temperature of 5 F, a condenser temperature of 86 F, and a heat source at 140 F, the refrigerants, propane, Freon-22 and Freon-12, had performance factors of the order of 0.2. Curves are presented to show the effect of changes in operating temperatures on the performance factor. The calculations indicate that an ejector refrigeration system would appear to be a feasible method for producing refrigeration from low-temperature energy sources.

From authors' summary

5142. Bolin, R. E., and Bainbridge, A. E., Estimation of dryness fraction and mass discharge of geothermal bores, Instn. mech. mech. Engrs., Prepr., 11 pp., 1958.

A method is described in which flow nozzles were used for investigating steam-water mixtures discharging horizontally from geothermal bores. British Standard and 25° approach nozzles were modified, so that the density in a small column, with the throat diameter as axis, could be estimated by measuring the absorption of beta rays in their passage diametrically through the mixture. A single density determination is shown to be sufficient to estimate the dryness fraction. If the upstream pressure is also noted then the mass output can be calculated using an empirical equation similar in form to the single-phase mass-discharge equation derived from Bernoulli's principle. For the dryness fraction one calibration curve suffices for 25° approach nozzles of various diameters. By nozzle rotation the angular distribution of the water was measured and hence its cross-sectional area.

From authors' summary

5143. Hall, J. A., and Leaver, Vera M., The emergent column correction in mercury thermometry, *J. sci. Instrum.* **35,** 3, 93–96, Mar. 1958.

The conditions which determine the accuracy of measurement of the emergent column temperature when mercury thermometers are used at partial immersion are discussed. The method of measuring the emergent column temperature used at the National Physical Laboratory is described, a table of the average values experienced is given, and the reasons in favor of testing thermometers at the immersion at which they are to be used are explained.

From authors' summary

5144. Giedt, W. H., Temperature measurement in solids, *Prod. Engng.* **29,** 29, 65–67, July 1958.

Increased operating temperatures in highly stressed material call for knowing the exact temperature at the exact point. Paper describes several methods of obtaining this information.

From author's summary

5145. Urbain, G., and Kissel, R., Aspiration pyrometers (in French), *Chaleur et Industrie* **38,** 389, 318–324, Dec. 1957.

Heat and Mass Transfer

(See also Revs. 4838, 4883, 5027, 5043, 5064, 5128, 5133, 5138, 5139, 5141, 5142, 5143, 5144, 5145, 5196, 5239, 5241, 5250, 5255, 5256)

Book—5146. Rase, H. F., and Barrow, M. H., Project engineering of process plants, New York, John Wiley & Sons, Inc., 1957, xii + 692 pp. $14.25.

Authors treat nearly all the problems involved in the design and construction of a process plant including legal and business

matters. The wide scope of this subject necessitates treating most of the material only briefly; however, the design and description of plant equipment is presented in detail. Business and legal procedures are illustrated by examples of letters and contracts in place of lengthy descriptions.

A complete chapter is devoted to each of the most common equipment types, such as vessels, heat exchangers, process pumps, and motors. For these the design equations are developed, their limitations pointed out, and examples of their use given.

Descriptions of equipment include many drawings for easy visualization. The selection of more specialized equipment such as centrifuges, autoclaves, cooling towers, etc., is described in a single chapter. The information required by the vendor of each type is listed. Numerous references are given at the end of each chapter.

Authors state book was designed as a reference for the practicing project engineer and as a text for the student. Reviewer believes the broad coverage is excellent for the student and the engineer not already versed on the subject; its value to the project engineer, with the exception of the detailed equipment design sections, is limited to an illustrated and well-indexed source of reference for nearly all aspects of process plant designs.

N. M. Nerheim, USA

5147. Jackel, H., Mathematical treatment of controlled cooling and heating processes (in German), *Ing.-Arch.* **26**, 146–156, Mar. 1958.

Paper concerns the solution of the equation of thermal conduction if the choice of admissible boundary conditions is so wide that the surface temperature of a solid body may be considered as an arbitrary function of position and time. A Green's function is defined which depends upon the coordinates of a point on the surface and a point in the interior of the solid body and upon the time interval necessary for the transmission of heat between these points. This Green's function is obtained in the form of an expansion in eigenfunctions, comparable to the familiar expansion of the temperature.

The method is applied to conduction of heat in a cylindrical solid the surface temperature of which is varied in an involved manner. Another example for the author's method is provided by the temperature distribution in a block of cement during the process of hardening.

R. Eisenschitz, England

5148. Ferreira Da Silveira, A. E., Computation of the temperature variations in concrete dams (in Portuguese), *Minist. Obras Publ., Lab. Engen. civ. Lisboa Pub.* no. 108, 17 pp., 1957.

The method for computing the temperature variations in a concrete dam which has lost all cement hydration heat is presented in this paper. Solar radiation effect was not considered.

The case of the semi-indefinite solid, the face of which is subjected to periodical temperature variations is dealt with, as well as the cases of the slab subjected to periodical temperature variations on one face only, temperature being zero at the other face, the case of the plate subjected to periodical temperature variations in phase or out of phase and with equal and unequal amplitudes.

Curves of different parameters were drawn for the case of the slab, in function of a dimensionless coefficient. These curves make it possible to calculate quickly both the temperatures at points lying at 1/8, 1/4, 1/2, 3/4 and 7/8 the thickness of the slab and the mean temperature variation along the thickness of the slab.

The expressions leading to the maximum and minimum temperatures for the different temperature conditions of the faces of the slab are also presented.

An example is given at the end.

From author's summary

5149. Burshtein, A. I., An investigation of the steady-state heat flow through a current-carrying conductor, *Soviet Phys.-Tech. Phys.* **2**, 7, 1397–1406, June 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27**, 7, 1510–1520, July 1957 by Amer. Inst. Phys., Inc., New York, New York.]

The conductor is a rod thermally insulated against surroundings and kept at constant temperatures T_0 and T_1 at its ends. An electric current I is passed through the rod in axial direction and heat is produced at a rate $I^2\rho$ according to Joules's law. Further heat is generated or removed at a rate $IrdT/dx$, depending on whether heat and current flow in the same or opposite directions. ρ is the resistivity, r the Thomson coefficient, T the temperature, and x distance in axial direction.

The heat balance in the rod yields a second-order ordinary differential equation. This can easily be solved for constant values of ρ, r and k (heat conductivity). Introducing a new variable $z = -ks(dT/dx)/I$ (s cross section of rod), the differential equation is transformed to a nonlinear form which can be solved in closed form in particular cases, and among these the limiting cases $z \ll \rho k/r$ and $z \gg \rho k/r$ are dealt with in detail. If the heat flow is predominantly due to the temperature between the ends of the rod, a general first-order approximation to the solution is given. Reviewer notes, however, that this solution could be derived much more easily directly from author's Eq. [4].

H. Schuh, Sweden

5150. Al'tshuler, L. M., The temperature field of tubes in a solid body, *Soviet Phys.-Tech. Phys.* **2**, 7, 1382–1389, June 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27**, 7, 1495–1509, July 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

The tube is laid in a semi-infinite solid body at constant depth beneath a body-air interface, at which heat is transferred according to Newton's law. Initially the temperature of the air and that of the body are the same. The air temperature is assumed to vary with time. The tube is treated as a linear heat source concentrated on its axis and hence results are valid only if distances are large compared with tube diameter. An analytical solution is obtained with the help of Green's function and can be extended to rows of tubes by the principle of superposition. Only Russian literature is quoted.

To reviewer's knowledge only steady-state solutions are known in the western world; among those however are some for finite tube diameters.

H. Schuh, Sweden

5151. Shumakov, N. V., A method for the experimental study of the process of heating a solid body (in Russian), *Soviet Phys.-Tech. Phys.* **2**, 4, 771–781, Apr. 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27**, 4, 844–845, Apr. 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

A method called "method of successive intervals" is presented for determining the boundary functions characterizing the heat exchange during heating or cooling an infinite plane-parallel plate from experimentally found time dependences of changes of the temperature field in the plate. The process of heating is broken up into separate time intervals and the temperature distribution in the plate in each interval is computed on the supposition that the boundary function is constant. Solution obtained gives a connection between the temperature field in the plate during the heating process and the variable thermal fluxes entering the plate at definite stages of the heating process. An analysis is made of questions relating to the construction of a device for studying the local nonstationary heat transfer between solid bodies of large dimensions and complicated configuration and the surrounding medium based on a measuring element consisting of a cylindrical portion of such an infinite plane-parallel plate.

F. Krupka, Czechoslovakia

5152. Kudriavtsev, E. V., and Shumakov, N. V., The method of average temperature for the study of the process of heating a solid body (in Russian), *Soviet Phys.-Tech. Phys.* **2**, 4, 782–793, Apr. 1958. [Translation of *Zh. tekh. Fiz. Akad. Nauk SSSR* **27**, 4, 856–867, Apr. 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

On the basis of the analysis of several cases of nonstationary bilateral heat transfer to or from an infinite plane-parallel plate of thickness $2R$, authors conclude that the variation with time of temperature at the plane with the coordinate $(3)^{1/2} R/3$ corresponds satisfactorily to the variation of the average plate temperature for any form of the boundary function. Since the amount of heat entering a body during a heating process is given by the product of its heat capacity and the increase of its average temperature it is then possible, from the experimentally found time-temperature relation in a point of the mentioned plane, to determine the density of thermal fluxes averaged over suitably chosen successive time intervals and to find out the form of the boundary function characterizing the heat exchange.

F. Krupka, Czechoslovakia

5153. Winterberg, F., Special fuel distributions and cooling problems in reactors of nuclear energy rockets (in German), *Astronaut. Acta* **4**, 2, 138–165, 1958.

Special distributions of the heat production in reactors of nuclear energy rockets are discussed, which allow the most favorable heat transfer. The appropriate fuel distributions are calculated for some simple geometric conditions. Favorable fuel distributions are those that result in a constant density of expended energy in the core of the reactor, and others where the surface temperature of the cooling channels remains constant.

From author's summary

5154. Lohner, K., and Chone, G., Heat transfer in ribs and ribbed cylinders (in German), *Motortech. Z.* **18**, 12, 373–377, Dec. 1957.

Data for heat-transfer calculations on fins or finned cylinders are scattered in the literature and partly inacessible. Such data are evaluated, collected and expanded through newly computed nomograms, and are arranged to suit present-day requirements. Equations and nomograms, necessary for heat-transfer calculations under various conditions, are presented. Special consideration is given to the determination of fin dimensions for maximum heat transfer.

From authors' summary

5155. Hak, J., Possibilities and outlook for an unrestricted solution of the heating problems of electric machines (in German), *Electrotech. u. Maschinenb.* **74**, 14, 305–311, July 1957.

Paper discusses the possibilities of joint treatment of the ventilation and heat-transfer problems. It is stated that the pressure difference due to the fan or due to the blowing effect of the rotor can be calculated by Atkinson's rule. Problem of the resistance of the air flow, heat transfer and heat flow are discussed. The method of the one-dimensional heat flow requires an iterative solution. By using the method of limited number of heat sources and nets, ambient temperature is assumed and later on corrected. Author believes that by extending the method of heat sources it will be possible to obtain practical and useful results. Large number of heat sources and heat resistances must be used to obtain a solution for the average temperatures at any point of the electric machine.

P. P. Biringer, Canada

5156. Fradkov, A. B., On the question of new methods of heat insulation for apparatus of intense cold (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **81**, 4, 549–551, 1951. (Translated from Russian by M. D. Friedman, Inc., Needham Heights, Mass., F-118, 4 pp.)

5157. Ostrach, S., and Albers, L. U., On pairs of solutions of a class of internal viscous flow problems with body forces, *NACA TN* 4273, 14 pp. + 3 tables + 5 figs., June 1958.

In previous analyses [*NACA TN* 2863, 3141, 3458; *Trans. ASME* Oct. 1953] of fully developed combined forced- and natural-convection flows, a few examples were presented of two distinct states of flow and heat transfer which were obtained for a given set of conditions if the frictional heating was taken into account. This report discusses these pairs of solutions in greater detail and shows how the solutions are affected by systematic variations of the basic physical parameters. It is also shown that a critical set of parametric values exists beyond which no fully developed solutions can be found.

From authors' summary by Y. S. Touloukian, USA

5158. Miropolskii, L., and Shitsman, M. E., Heat transfer to water and steam at variable specific heat (in near-critical region), *Soviet Phys.-Tech. Phys.* **2**, 10, 2196–2208, June 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27**, 6, 2359–2372, Oct. 1957 by Amer. Inst. Phys., Inc., New York, N.Y.]

Extrapolation of heat-transmission data from non-boiling water or from superheated steam into the range of the critical temperature gives unsatisfactory results because of large variations of the Prandtl number. New measurements at 220 atm pressure, 373–380C have been carried out with an apparatus previously described. Whether Pr should be taken at fluid temperature (subscript f) or at wall temperature (w) depends upon the value Pr_f/Pr_w. If $Pr_f > Pr_w$ (heating of steam), Pr_w is the determining factor; if $Pr_f < Pr_w$ (heating of water), Pr_f is the determining factor. The respective factor is termed Pr_m and optimum correlation of the measurements is obtained by the equation $Nu = 0.023 (Re_f)^{0.8} (Pr_m)^{0.4}$

W. [illegible]mz, Germany

5159. Ambrok, G. S., Approximate solution of equations for the thermal boundary layer with variations in boundary layer structure, *Soviet Phys.-Tech. Phys.* **2**, 9, 1979–1986, May 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27**, 9, 2134–2142, Sept. 1957 by Amer. Inst. Phys., Inc., New York, N.Y.]

The analysis in this paper is based on the thermal integral relation which corresponds to the "von Karman integral relation" of momentum transfer. With varying usage of empirical results, author derives working formulas for local Nusselt number as a function of Reynolds number, and of downstream free-stream velocity and wall temperature distributions. Both laminar and turbulent cases are presented, with a suggested formula for transition region as well.

The turbulent formula is compared with some new experimental flat plate results for both favorable and adverse pressure gradients.

Finally, laminar, transition, and turbulent formulas are all tested by comparison with new data for heat transfer around typical turbine blade profiles. The agreement seems reasonable.

S. Corrsin, USA

5160. Tendeland, T., Effects of Mach number and wall-temperature ratio on turbulent heat transfer at Mach numbers from 3 to 5, *NACA TN* 4236, 19 pp. + 11 figs., Apr. 1958.

Heat-transfer data were evaluated from temperature-time histories measured on a cooled cylindrical model with a cone-shaped nose and with turbulent flow at Mach numbers 3.00, 3.44, 4.08, 4.56, and 5.04. The experimental data were compared with calculated values using a modified Reynolds analogy between skin friction and heat transfer. Theoretical skin-friction coefficients were calculated using the method of Van Driest and the method of Sommer and Short.

The heat-transfer data obtained from the model were found to correlate when the T' method of Sommer and Short was used.

The increase in turbulent heat-transfer rate with a reduction in wall to free-stream temperature ratio was of the same order of magnitude as has been found for the turbulent skin-friction coefficient.

From author's summary by C. C. Eckles, USA

5161. Imai, I., On the heat transfer to constant-property laminar boundary layer with power-function free-stream velocity and wall-temperature distributions, *Quart. appl. Math.* **16,** 1, 33–45, Apr. 1958.

The system of nonlinear partial differential equations expressing the conservation relations for a constant property laminar boundary layer reduces by the Falkner-Skan transformation to a pair of ordinary differential equations in the case when the free-stream velocity and wall-temperature distributions are expressible as power functions of x. With the Hartree solution available for the first of these, the second (for the temperature distribution) may be regarded as a linear differential equation of the second order with known variable coefficients. Author solves this equation by a modified WKB method, the local heat-transfer coefficient coming out in terms of algebraic functions of m, n, and σ, where m and n are the velocity and temperature powers respectively, and σ is the Prandtl number. Applying the results to the cases of Blasius flow ($m = 0$) and stagnation flow ($m = 1$) gives answers in very good agreement with Levy's numerical solutions, and better than previous approximate analytical formulas.

L. M. Grossman, USA

5162. Chu, B.-T., and Kovasznay, L. S. G., Non-linear interactions in a viscous heat-conducting compressible gas, *J. Fluid Mech.* **3,** 5, 494–514, Feb. 1958.

Extending to viscous heat-conducting compressible flows the basic assumption in the turbulence theory (in a space-time domain of suitable size all variables fluctuate around their fundamental values, and fluctuations obey classic fluid dynamics equations), authors develop an iterative procedure in which each step is described by means of linear differential equations. First and second step are thoroughly analyzed.

In the first step, three typical modes of fluctuations appear: the vorticity mode, as in incompressible turbulent flow; the sound mode, as in conventional acoustics; the entropy mode, as in turbulent heat-transfer problems. Six interactions between these fundamental modes may occur, each one acting differently to produce second-order fluctuations of the types mentioned above. Analysis is made of the nature of each interaction, trying to split the complicated nonlinear phenomena into simpler ones. Relative importance of each interaction on each fundamental mode is determined.

In reviewer's opinion, paper is very interesting from the point of view of physical understanding and affords a guide to the theoretical interpretation of experimental data.

G. Moretti, Argentina

5163. Probstein, R. F., Adams, M. C., Rose, P. H., On turbulent heat transfer through a highly cooled partially dissociated boundary layer, *Jet Propulsion* **28,** 1, 56–57, Jan. 1958.

Some analytical results regarding the properties of a compressible dissociating turbulent boundary layer in thermodynamic equilibrium are given. The equations of motion have been averaged in the usual manner for the mean velocity components and simplified according to the boundary-layer assumptions. A relation between enthalpy and velocity (Crocco integral) has been obtained when the laminar and turbulent Prandtl and Lewis numbers are unity, and the pressure gradient in the flow direction is zero. The Nusselt number has been estimated for flow with nonvanishing pressure gradient by using the results for zero pressure gradient in the case of a highly cooled wall.

S. D. Nigam, India

5164. Reshotko, E., Heat transfer to a general three-dimensional stagnation point, *Jet Propulsion* **28,** 1, 58–59, Jan. 1958.

The equations for the compressible laminar boundary layer have been simplified in the neighborhood of a general three-dimensional stagnation point. It is pointed out that in the vicinity of the stagnation point the general coordinate system [L. Howarth, *Phil. Mag.* (7), **42.** 1433–1440, 1951; AMR **5** (1952), Rev. 2434] is Cartesian. Solutions of the flow and energy equations are given for the case of a very cold wall for Prandtl number unity. Due to the first restriction the flow equation is independent of the temperature. The variation of the temperature gradient at the wall with K^2, the ratio of the principal radii of curvature, is given in the form of a graph. Estimates based on this solution are made for the heat transfer at other temperature levels.

S. D. Nigam, India

5165. Ede, A. J., and Saunders, O. A., Heat transfer from a flat surface to a parallel stream of water, Instn. mech. Engrs., Preprint, 16 pp., 1958.

Author gives a very detailed description of heat-transfer measurements where a flate plate is cooled by water of 13 to 120 cm/s. The heated part of the plate could be arranged in various distances from the nose. The results of the heat-transfer measurements in laminar and turbulent flow are in agreement with the theories of E. R. G. Eckert ["Introduction to the transfer of heat and mass," McGraw-Hill Book Co., New York, 1950; AMR **3** (1950), Rev. 2055] and P. R. Owen and A. O. Ormerod [*Roy. Aircraft Establ. Rep.* no. Aero 2431, 1951].

Margot Herbeck, Germany

5166. Silveston, P. L., Heat flow in horizontal liquid layers Parts I and II (in German), *Forsch. Geb. Ing.-Wes.* **24,** 1, 29–32, 1958; **24,** 2, 59–68, 1958.

In a series of tests with different fluids (water, glycol, heptane and two silicon oils) the heat-transfer characteristics through layers varying in thickness from 1.5 to 13 mm have been determined. The results are plotted in a graph showing $Nu' = \lambda_k/\lambda$ as a function of the Rayleigh number ($= Gr \times Pr$). By means of schlieren photos the three main regions of the graph have been confirmed as being the pure conduction, laminar convection and, finally, turbulent convection zones. While the transition from first to second is easily recognized on graph and schlieren photos, the second-third transition is less distinct. The results are in agreement with previous data and because they are expressed in simple equation form for each region the reader with very limited knowledge of German can easily understand the content of this report.

M. Rand, Canada

5167. Boyarshinova, A. A., Some results of an investigation into the heat convection flow in a vertical cylinder of restricted length (in Russian), *Ucb. zap. Molotovsk. un-ta* **9,** 4, 61–70, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3193.

A column of water in a glass tube was enclosed between copper pistons: one hot, below, and one cold, above. Simultaneously with an upward motion of the cold piston, the temperature difference between the pistons was recorded photographically. With increasing height of the column of water, for each value of the intensity of heating, three different conditions of heat exchange were observed. The results obtained are discussed in detail.

M. P. Sorokin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5168. Gershuni, G. Z., The problem of the steadiness of the two-dimensional convective motion of a fluid (in Russian), *Zh. tekh. Fiz.* **25,** 2, 351–357, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3187.

The stability is investigated of the steady-state, convective motion of a fluid in an arbitrarily oriented gap formed between two parallel planes, having a constant temperature difference. The case of the horizontal gap has been examined by Rayleigh [*Phil. Mag.* **32**, p. 529, 1916] and others; an approximate solution for the vertical gap has been obtained by the author. Two-dimensional perturbations of the motion with different wave numbers, periodic along the coordinate directed along the gap, are examined. The approximate critical values of the wave numbers are found by the Galerkin method from the linearized equations of the perturbation. The simplest approximation is found valid only for the case of the horizontal, or nearly horizontal, gap heated from below. It is found that in such orientation of the gap, the cause of the discontinuous appearance of convection is the instability of the fluid equilibrium when heated from below, i.e., the "convection threshold." The next more complex approximation is found to be suitable for the case of a gap near to the vertical and heated from below, or with an arbitrary inclination, but heated from above. It is found that in this case the cause of the appearance of a critical point is not the existence of a "threshold of convection" but the hydrodynamic instability of the original motion.

L. N. Gutman

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5169. Lineykin, P. S., The theory of self-induced oscillations in a convection flow (in Russian), *Trudi Gos. okeanogr. in-ta* no. 23, 16–23, 1953; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3189.

The self-induced oscillations in the velocity field and the temperature field of a convection flow are investigated. The interest in the calculation of the possible periods of self-induced oscillations in the atmosphere, depending on the physical and geographical conditions, is motivated by the consideration that such self-induced oscillations can form the basis for the formation of natural, synoptic periods.

The problem is solved for the case of two-dimensional motion on the assumption of a linear relationship between the heat loss at the boundary of the fluid and the flow velocity of the liquid around the (solid) boundary, as well as a linear relationship between the density of the fluid and the temperature. For an ideal fluid, the existence of dissipative forces proportional to the flow velocity is assumed.

The simplified equations of unsteady convection (i.e. in the presence of oscillatory perturbations) are reduced to nondimensional terms in the system of equations

$$\beta \frac{\partial \xi'}{\partial t} = \gamma \frac{\partial \omega}{\partial x} - \epsilon\gamma \frac{\partial \psi'}{\partial x} - \mu\xi - D(\psi', \xi_0) - D(\psi_0, \xi') - D(\psi', \xi')$$

$$\beta \frac{\partial \omega}{\partial t} = \epsilon\beta \frac{\partial \psi'}{\partial t} + p\nabla^2\omega - \epsilon p\xi' - D(\psi', T_0) - D(\psi_0, \omega) + \epsilon D(\psi_0, \psi') - D(\psi', \omega)$$

where $\omega = T' + \epsilon\psi'$; T' and ψ' being the perturbations of the stream function and the temperature in the liquid with reference to T_0 and ψ_0 satisfying the fundamental equations of steady convection in the region investigated; D Jacob's coefficients of the corresponding functions; $\xi = \nabla^2\psi$ = eddy.

The values β, γ, ϵ, μ, p are the parameters of the problem. The functions ψ, ω on the contour Γ of the region occupied by the fluid satisfy the following conditions:

$$\psi_\Gamma' = 0 \qquad \partial\omega/\partial n_\Gamma = 0$$

The solutions of the reduced equations are found in the form of expansions by powers of the parameter ϵ:

$$\psi' = \epsilon\psi_1 + \epsilon^2\psi_2 + \dots$$

$$\xi' = \epsilon\xi_1 + \epsilon^2\xi_2 + \dots$$

$$\omega = \epsilon\omega_1 + \epsilon^2\omega_2 + \dots$$

The equations of the problem at this stage are reduced to a system of homogeneous, integrodifferential equations. General indications are given on finding the successive approximations and, as a result thereof, the values of the period of oscillation.

P. N. Uspenskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5170. Sorokina, A. I., and Tchudinov, A. A., The free steady-state convection between two vertical, coaxial cylinders (in Russian), *Ucb. zap. Molotovsk. in-ta* **9**, 4, 49–60, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3184.

The steady-state convective flow between two coaxial, vertical cylinders is analyzed. Between the cylinders is a fluid, heated from below. The walls are assumed to be nonconductive to heat.

The starting system of equations of the ordinary form is reduced to a system of two linear, differential equations of the second order, which is rigorously solved in Bessel functions for the radially symmetrical and antisymmetrical cases.

K. K. Vasilevskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5171. Hartree, D. R., A method for the numerical integration of the linear diffusion equation, *Proc. Camb. phil. Soc.* **54**, 2, 207–213, Apr. 1958.

In one numerical method for integration of the diffusion equation in one dimension, the time derivative is replaced by a finite difference in a time interval. This leads to a set of ordinary differential equations, one for each interval, which have to be solved in succession. Each of these equations is second-order with two-point boundary conditions; the process of integration from one end is severely unstable, the more so the smaller the time interval. This paper is concerned with a practical, direct and stable method for solving them by integration of two first-order equations, one being integrated inwards and the other outwards, one boundary condition being satisfied in each integration. The extension to axially symmetrical diffusion is briefly considered.

From author's summary by Y. L. Luke, USA

5172. Elworthy, P. H., Diffusion measurements by a sampling technique, *J. sci. Instrum.* **35**, 3, 102–103, Mar. 1958.

An apparatus has been devised for measuring diffusion coefficients by withdrawing a small sample of the diffusion column and analyzing it. The errors normally present in layer analysis methods have been minimized. Providing the volume of the sample was kept within certain limits, and the rate of withdrawal was slow, diffusion coefficients could be measured accurately. The determination of diffusion coefficients of various substances gave values which agreed excellently with known values. The method was precise to 0.4%. From author's summary

5173. Fiks, V. B., On the influence of convection on diffusion, *Soviet Phys.-Tech. Phys.* **2**, 6, 1176–1183, Feb. 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27**, 6, 1262–1288, June 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

Diffusion in a liquid moving in a long tube of uniform arbitrary cross section is considered. At any point in a cross section z, the flow velocity is parallel to the wall and independent of z, and of time t. By a statistical argument, considering random movements of particles, it is shown that the mean concentration is governed by the normal diffusion equation. Reviewer feels that this could have been done without a statistical argument; a comparison with other recent work (AMR **6** (1953), p. 265; and *Appl. sci. Res. (A)* **5**, p. 374, 1956) would have been useful.

J. F. Davidson, England

5174. Schwez, I. T., and Dyban, E. P., Cooling of gas-turbine wheel disks (in German), *Motortech. Z.* **18**, 12, 394–396, Dec. 1957.

The report concerns itself with the effect of aircooling on the temperature distribution of gas-turbine wheel disks.

According to authors' method the temperature distribution of the disk can be determined assuming suitable limit conditions for blowing cooling air radially upon the disk and for blowing cooling air through the clearance fit of the blade roots. The relationship of the disk thickness to the radius is of minor importance.

The critical diameter selected for the heat transfer of the disk is the one where the temperature difference between blade root and disk is zero, so that the isotherm is a concentric circle around the center of the disk.

The flow of cooling air through narrow passages has been experimentally determined. Some statements are made about heat transfer and pressure losses in capillary passages.

Finally reference is made to the calculation methods for disk cooling systems as they were developed by the Institute of the Academy of Science in the USSR.

From authors' summary

5175. Broido, A., and Willoughby, A. B., Measurement of intense beams of thermal radiation, *J. opt. Soc. Amer.* **48**, 5, 344–350, May 1958.

Instrument described is a copper-block calorimeter for monitoring thermal radiation emitted by nuclear detonations. Intensity of radiation is obtained by differentiation of oscillographic record of temperature of a copper disk that acts as receiver of radiation.

R. Gardon, USA

5176. Lubny-Gertsyk, A. L., Certain new methods of approximate calculation of radiative heat transfer, *Soviet Phys.-Tech. Phys.* **2**, 6, 1255–1268, Feb. 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27**, 6, 1357–1370, June 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

Various problems of heat transfer between radiating gas, stationary or moving, and fixed solid walls are considered.

In the first problem a radiating block of grey gas at uniform temperature is either cubical, spherical, or cylindrical, and of size r. Heat is generated at constant rate within this gas which is surrounded by inert gas enclosed by a solid surface of size R, and the same shape as the block of radiating gas. Numerical values of the effective emissivity between the gas and the solid surface are obtained by solving the differential equations of radiant transfer within the gas.

For a selectively absorbing gas, an alternative to Schack's method of calculating total absorption is suggested, but not worked out. The method uses a function giving the probability of all absorption coefficients.

Next to be considered is a grey emitting gas at temperature T, filling the space between absorbing tubes which traverse the gas in all directions and are at a temperature T_t. The whole is surrounded by an enclosure at T_w, and numerical results are given for a cylindrical enclosure.

The next problem is the flow of a grey emitting gas along a tube. Mixing and convective heat transfer are neglected. With an assumed form of temperature distribution at any section, the variation of the mean temperature along the tube is obtained numerically by integration of emissions of individual elements.

The final problem is the flow of a grey emitting gas normal to a large plane surface, which may be partly transparent and is pierced by a number of holes to let the gas through. The gas extends to infinity on either side of the plate. Curves are given to calculate the radiant heat transfer to the plate.

A useful paper, which would be more readable with a list of notations, and with more detail about the calculations leading to the given curves.

J. F. Davidson, England

5177. Konakov, P. K., Filimonov, S. S., and Khrustalev, B. A., Calculation of heat exchange by radiation in cooled combustion chambers, *Soviet Phys.-Tech. Phys.* **2**, 5, 971–979, Feb. 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27**, 5, 1066–1075, May 1957 by Amer. Inst. Phys. Inc., New York, N. Y.]

Theoretical and experimental proof is given in this paper for the presence of radiation equilibrium close to heat-absorbing surfaces, making possible the determination of the radiation temperatures on the heat-absorbing surfaces and therefore the calculation of the heat exchange by radiation in combustion chambers.

From authors' summary by R. L. Young, USA

5178. Grassmann, P., Karagunis, A., Kopp, J., and Frederking, T., Heat transfer to liquid helium by nucleate and stable film boiling (in German), *Kaltetechnik* **10**, 7, 206–208, July 1958.

The heat-transfer coefficient for nucleate boiling has been determined at different boiling temperatures by means of electrically heated probes. The temperature difference ΔT between the probe surface and liquid helium covered a range from 0.1 to 1 K. To measure the heat-transfer coefficient for film boiling ($30 < T < 1000$ K), thin wires of platinum or wollaston placed in horizontal and vertical position have been used. In the investigated range of temperatures the heat-transfer coefficient for wire diameters between 5 and 50 μ is approximately proportional to $\Delta T^{0.28}/d^{0.7}$.

From authors' summary

5179. Koch, W., Experimental investigations into drying with infrared rays in the constant-rate period (in German), *VDI-Forschungsheft (B)* **465**, 24, 40 pp., 1958.

Drying tests were performed with infrared rays in the constant-rate period of various materials using a special test canal which allowed for setting up any desired state of the drying air and for applying different radiation sources. An influence on the drying process of the support, upon which the samples were put in the drying canal, was noted in the case of short-wave infrared radiation only. With long-wave infrared radiation, under otherwise equal drying conditions, the rate of drying did not differ much from an average value obtained from the results for all materials investigated. Measurements of the apparent total transmissivity and of the total reflectivity revealed the influence of the moisture content of the materials on the drying process. The temperature of the samples, as measured for a variety of drying conditions, provided an insight into the drying mechanism. Drying rate curves were analyzed with regard to air conditions. The measured effect of air velocity, air humidity, and air temperature on the drying process during the first drying period could be supported by considerations based on a heat balance.

From author's summary

5180. Kudryashev, L. I., and Vishnevsky, K. P., The calculation of the coefficient of convective heat exchange in the condensation of steam on vibrating tubes (in Russian), *Sb. nauch. tr. Kuybyshevsk. industr. in-ta* no. 5, 160–165, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3200.

A semi-empirical, standard formula is derived for calculating the Nusselt number for the heat exchange in the condensation of steam on vibrating horizontal tubes.

G. A. Tirskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5181. Styrikovich, M. A., and Schutzmann, M. E., An investigation of the temperature conditions in the working of a vertical, steam-generating tube at supersonic pressures (in Russian), "Hydrodynamics and heat exchange in boiling, in high-pressure steam generators." Moscow, Akad. Nauk SSSR, 1955, 206–228; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3203.

The results are presented of an experimental investigation into the temperature conditions of a vertical steam-generating tube with

an internal diameter of 30 mm. The tests were made on a test bench at pressures from 182–200 atm abs, a unit heat flow between 230–720 thousand kcal/m²/hour, circulation velocities between 0.2 and 2.2 m/sec, and steam percentages, by weight, of 8 to 100%.

It has been found that, in the investigated region of pressures and circulation parameters, there exists a considerable zone of intermediate conditions, in which the intensity of the heat transmission gradually decreases with increasing steam percentage from values corresponding to normal ebullition to values representing heat transfer to dry, saturated steam. It is pointed out that, for a unit heat flow of the order of 400–450 thou.kcal/m²/hour, a reduction of the circulation velocity to 0.4–0.5 m/sec and the rate of circulation to 2.0–2.5 may cause damage to the steam tubes of boilers working at supersonic pressures.

Z. L. Miropol'skii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5182. Gelperin, I. I., and Minsker, K. S., The determination of heat transfer surface for the case of zero temperature difference between cooled and coolant fluids at the end point of flow, *Soviet Phys.-Tech. Phys.* **2**, 9, 1987–1992, May 1958. [Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **27**, 9, 2143–2148, Sept. 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

Authors briefly describe the use of a particular heat exchanger in the extraction of components from gas mixtures by fractional distillation. The primary hot fluid is cooled by a secondary coolant, and also by the cooled primary fluid in a recuperative way. Logarithmic mean temperature differences lose their meaning with such boundary conditions, and authors derive a solution for finding the necessary heat exchange area for a counterflow arrangement, assuming constant film coefficients. The corresponding result for a parallel-flow arrangement is also stated, and a numerical example is given. Y. R. Mayhew, England

5183. Kadirov, N. B., Methodology of the verifying calculations of heat exchangers (in Azerbian), *Trudi Azerbeidj. industr. in-ta* no. 11, 119–131, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3212.

The question is discussed of the most rational methods for verifying calculations of tubular heat-exchanger systems, which is treated as a problem of determining the final temperatures of the hot and cold media and the quantity of transmitted heat, from predetermined temperatures and water equivalents of the working media, at fixed parameters of the heat exchanger (i.e., number of tubes, their length, internal and external diameters). The problem is presented in a very general manner; account is taken not only of the thermal resistance of the wall, but also of the variability of the heat conductivity of the metal with temperature; similarly, the change in specific heat of the media with temperature. Applying formulas obtained earlier for the characteristic temperatures of the media, author demonstrates that the problem can be reduced to a system of equations, the number of which depends on the flow conditions in the media. It is proposed to solve the system of equations by the method of successive approximation. Explanations are given of the application of the proposed calculation method in specific cases of uniflow and counterflow heat exchangers, in the presence of turbulent and laminar flow of the media, respectively.

A. A. Gukhman

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5184. Romanenko, S. V., Gas-dynamical analysis of heat exchangers (in Russian), *Izv. Akad. Nauk SSSR, Otd. tekh. nauk* no. 3, 39–50, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3211.

The steady-state problem is solved of the heat exchange between a gas moving with high velocity along a duct of constant cross section (first heat carrier) and some other fluid (second heat carrier) in uniflow and counterflow conditions. A unidimensional model is examined. A number of simplifications are introduced: (1) The coefficient of hydrodynamic resistance ζ is assumed to be constant; (2) the coefficient of heat loss α from the first heat carrier is constant; (3) the coefficient of heat loss from the second heat carrier is constant; (4) the specific heats of both heat carriers are constant along the heat flow; (5) the thermal resistance of the wall dividing the heat carriers is negligible. In addition it is assumed that in all conditions the fundamental relationship of the hydrodynamic theory of heat exchange $\alpha = (\zeta/8)\, c_p\, \gamma w$, in which c_p is the specific heat at constant pressure, γ the specific gravity of the medium, w the gas velocity, remains valid.

On these assumptions an equation is obtained relating the retardation temperature T_0 and the referred gas velocity $\lambda = w/a_*$, where a_* is the critical speed of sound

$$(\lambda^2 - 1)\,\frac{(d\lambda^2)/\lambda^4}{(dT_0)/T_0} = \frac{1}{n} - \frac{1}{\lambda^2}$$

where

$$n = \frac{1 - T/T_0}{[4k/(k+1)]\,u^{-1} - 1 + T/T_0}$$

is a nondimensional parameter important for the whole theory presented (k index of the reversible adiabatic; u the thermally active portion of the perimeter; T the temperature at the wall).

A qualitative analysis of the equation shows that for a gas flow in the presence of heat exchange with some other medium (in the process of heat transmission) the same specific effects are characteristic as have already been determined for the case of heat exchange between a gas and a wall (i.e., the case of heat loss). The heating of a gas is always accompanied by its accelerated motion. In cooling, the position of the boundary between positive and negative acceleration is determined by the condition $\lambda^2 = n$. For $\lambda^2 > (k+1)/(3k-1)$, i.e., for $M^2 > k^{-1}$, only an accelerated flow is possible. Approximate solutions are presented for the cases of $\lambda^2 \gg |n|$, and $\lambda^2 \ll 1$. It is demonstrated that the solutions obtained correctly reflect the essential characteristics of the flow. For intermediate values of λ a method is suggested, founded on averaging the parameter n by sections. This method is found to be particularly effective for the case of $|n| \gg \lambda^2$.

In conclusion, the case is examined of a variation of the parameters of the gas along the duct. It is demonstrated that the known formula for the variation of λ in an adiabatic flow in the presence of friction can be obtained as the particular case from the more general relationships. A. A. Gukhman

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5185. Bystrova, T. A., Investigation of a regenerator-recuperator in a nonstationary thermal flow (in Russian), *Sb. statei Mosk. vyssh. tekhn. ucb-schha* **53**, 21–46, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2009.

5186. Challoner, A. R., Gundry, H. A., and Powell, R. W., A radial heat-flow apparatus for liquid thermal conductivity determinations, *Proc. roy. Soc. Lond. (A)* **245**, 1241, 259–267, June 1958.

A narrow Dewer-type radial heat-flow apparatus has been constructed in Pyrex glass and used for liquid thermal conductivity investigations. Calibration is made with liquids of known thermal conductivity, and new values are obtained for a few other liquids.

From authors' summary by F. R. Hama, USA

5187. Kertesz, J., Air curtain and its application in cold storages (in Hungarian), *Energia és Atomtechnika* **11**, 1/2, 70–73, 1958.

A door-free system for a cold-storage room is computed and formulas for the width of opening and necessary air flow are developed, following in 1953 German translation of "Lüftungsanlagen für Industriebauten," by W. W. Baturin.

S. Kolupaila, USA

Combustion

(See also Revs. 5137, 5176, 5177, 5240)

5188. Vlasov, K. P., Concerning a method for determining the turbulent speed of propagation of a flame (in Russian), *Soviet Phys.-Tech. Phys.* **2**, 2, 303–308, Feb. 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27**, 2, 338–344 by Amer. Inst. Phys., Inc., New York, N. Y.]

Author describes use of double probe (ionization) for determination of turbulent flame velocity. He compares ionization with optical method for establishing instantaneous flame-front position, and points out relative ease with which statistically useful data can be obtained from ionization probe. Author favors statistical treatment of short-duration measurements rather than self-averaging measurements (thermocouple or long-exposure photography) in the location of the turbulent flame front, because the averaging method in the statistical case is known and controllable.

J. S. Arnold, USA

5189. Biedler, W. T., III, and Hoelscher, H. E., Studies in a new type of flat flame burner, *Jet Propulsion* **27**, 12, 1257–1260, Dec. 1957.

The flat flame burner originated by Pauling and developed by Egerton and others was used as basis for a new burner design which has an adjustable plate above the burner and mixing chamber and which is simpler in design than earlier ones. Velocities above the flame, temperature traverses, and composition of gases issuing from the flame can be determined, as well as flame velocity, etc., provided flames are relatively slow-burning.

Data are given for preliminary studies on propane-air flames. The results show good agreement with earlier measurements by Egerton and Thabet.

R. C. Anderson, USA

5190. Halpern, C., Measurement of flame speeds by a nozzle burner method, *J. Res. nat. Bur. Stands.* **60**, 6, 535–546, June 1958.

The literature records a great many measurements, using stationary flames on burners, of the speed with which flame moves through combustible mixtures of gases. Despite the fact that the method itself seems reasonably simple, results obtained by various investigators often are not in good agreement. One of the phases of a program of research on combustion has been a study of some of the reasons for the differences among recorded values of flame speed measured by the burner method. The primary objective has been to develop the precautions to be observed in applying the method, rather than to evolve numerical values of flame speed. This paper describes progress that has been made since the apparatus was described originally in 1951, and presents values of flame speeds of methane-air mixtures obtained since then, together with comparisons of these values with those obtained by two flame theories.

From author's summary

5191. Webster, C. T., Flammability of thin flexible materials, *J. Text. Inst. Trans.* **48**, 12, 471–473, Dec. 1957.

Some further work on the flammability of fabrics is described, and an empirical equation is derived for the vertical flame speed in terms of the distance and time of spread of flame on the flammability apparatus described in British Standard 476: Part 2: 1955. This relationship, which is the basis of the figure of merit in the British standard, is considered to be more reliable than the equation relating distance of spread and flame speed given in an earlier paper.

From author's summary

5192. Shanley, E. S., and Perrin, J. R., Prediction of the explosive behavior of mixtures containing hydrogen peroxide, *Jet Propulsion* **28**, 6, 382–385, June 1958.

Paper concerns a relationship between thermal properties and explosive properties for mixtures containing hydrogen peroxide, water, and soluble organic compounds. It has been known for some time that certain mixtures of this kind are explosive. In the present study it has been found that sensitivity to initiation is about the same for all mixtures having the same heat of reaction. This relationship is demonstrated for five different organic constituents and for three methods of initiation. The findings provide an easy basis for predicting the likely range of explosive compositions of untested mixtures containing hydrogen peroxide.

From authors' summary

5193. Merk, H. J., Analysis of heat-driven oscillations of gas flows. III. Characteristic equation for flame-driven oscillations of the organ-pipe type, *Appl. sci. Res.* (*A*) **7**, 2/3, 175–191, 1958.

Using the results of previous papers in the series [title source **6**, 317–335, 1957; **6**, 402–420, 1957] author derives a characteristic equation for flame-driven oscillations of the organ-pipe type. Accordingly, transfer functions for the oscillations in pressure and velocity before and behind the flame front are derived. These are found to depend on fluctuations in the "normal combustion velocity" for which, in turn, transfer functions are defined relating to fluctuations in temperature and pressure in the flame front. By matching conditions for acoustic fluctuations on either side of the flame region, the characteristic equation is obtained. For low frequencies, an equivalent electric network may be used to investigate the flame stability.

M. A. Mayers, USA

5194. Merk, H. J., Analysis of heat-driven oscillations of gas flows. IV. Discussion of the theoretical results concerning flame-driven oscillations, *Appl. sci. Res.* (*A*) **7**, 2/3, 192–204, 1958.

In applying the results of the previous paper [see preceding review] to real flames, it appears that, in most cases, only the fluctuations in flame area are responsible for fluctuations in heat release. On this basis, the characteristic equation can be used to derive a condition of instability which, in effect, represents a mathematical statement of Rayleigh's criteria. The theory, as outlined up to this point, is applied to the "rocket-shaped" burner defined by Putnam and Dennis [*Trans. ASME* **75**, 15–28, 1953]. Qualitative agreement is found with the experimental results. This agreement suggests that analysis of the acoustic behavior of the flow system may be successful in explaining peculiar features of unstable combustion.

M. A. Mayers, USA

5195. Goldstein, A. W., Klapproth, J. F., and Hartmann, M. J., Ideal performance of valved-combustors and applicability to several engine types, *Trans. ASME* **80**, 5, 1027–1036, July 1958.

Pressure rise and flow capacity of valved combustors are estimated, and engine power and efficiency are calculated using valved-combustor characteristics with and without regenerators for stationary power turbines and for turbojet and ramjet engines. Results are compared with those from similar engines using unvalved combustors.

From authors' summary

5196. Godridge, A. M., and Thurlow, G. G., The Venturi pneumatic pyrometer, *J. sci. Instrum.* **35**, 3, 81–88, Mar. 1958.

An instrument for measuring gas and flame temperatures is described. From design considerations it is shown that the instrument can be used at higher temperatures than existing probe instruments and has a very rapid rate of response. The operation

of the instrument is discussed and examples of its use are given. In the downtakes of open-hearth furnaces and in water-tube boilers the instrument shows advantages over the suction pyrometer in speed of response and freedom from blockage. Results have also been obtained at temperatures higher than those at which any other method of obtaining local temperatures has proved successful. From authors' summary

Acoustics

(See also Revs. 4869, 5014)

5197. Johnson, W. R., and Laporte, O., Interaction of cylindrical sound waves with a stationary shock wave, *Physics of Fluids* **1,** 2, 82–94, Mar.–Apr. 1958.

The incident cylindrical sound wave is represented as a superposition of plane waves of varying direction. Each of the plane waves in this superposition interacts with the shock wave, giving rise to a previously determined distortion of the shock front and reflected or refracted wave field; the cylindrical wave causes a disturbance which may be written in integral form as a superposition of these plane waves. The resulting interaction integrals are evaluated asymptotically to give explicit formulas for the distortion of the shock, the sound field, and the entropy-vorticity wave. R. C. Binder, USA

5198. Gazarian, Iu. L., Wave duct propagation of sound for one particular class of laminarly-inhomogeneous media, *Soviet Phys.-Acoustics* **3,** 2, 135–149, Feb. 1958. [Translation of *Akust. Zh., Akad. Nauk SSSR* **3,** 2, 127–141, Apr.–June 1957, by Amer. Inst. Phys., Inc., New York, N. Y.]

An integral representation is derived for the field of a point spherical harmonic radiator located in an absorbing medium in which the speed of sound varies according to the law formulated and utilized by P. S. Epstein [*Proc. Nat. Acad. Sci.* **16,** 10, 627–637, Oct. 1930] in the case of electromagnetic waves. The propagation of sound is considered for a symmetrical Epstein layer, and relatively simple solutions are obtained in the special cases of an absolutely soft or an absolutely rigid boundary on the axis of the channel (propagation of sound in the ocean or in the atmosphere). The arbitrary Epstein layer is also examined mathematically. R. Heller, USA

5199. Parkin, P. H., and Scholes, W. E., Oblique air-to-ground sound propagation over buildings (in English), *Acustica* **8,** 2, 99–102, 1958.

The propagation sideways to the ground of the sound emitted by helicopters has been investigated in a built-up area. Over the horizontal distance covered (about 920 m (3000 ft)) it was found (a) that the attenuation (i.e. all losses in excess of the inverse square reduction) at frequencies up to 1000 c/s was small and independent of the weather for helicopter heights of greater than about 100 m (300 ft); and (b) that at lower heights, the attenuation increased considerably. From authors' summary

5200. Howes, W. L., Ground reflection of jet noise, *NACA TN* 4260, 33 pp. + 20 figs., Apr. 1958.

The effect of a reflecting plane is determined from theory and experiment. From the theoretical characteristics of far-field acoustic decay a correction-to-free-field procedure is developed for data obtained in the presence of a plane. Measurements of jet noise indicated the practical significance of reflections. Several theoretical predictions were confirmed from experimental decay curves and corrected spectra.

From author's summary by N. Tetervin, USA

5201. Gorshkov, N. F., The propagation of pulses in an electric absorptive medium, *Soviet Phys.-Acoustics* **3,** 2, 163–172, Feb. 1958. [Translation of *Akust. Zh., Akad. Nauk SSSR* **3,** 2, 154–162, Apr.–June 1957, by Amer. Inst. Phys., Inc., New York, N. Y.]

Propagation of a unit-function pulse in an elastic medium which has an absorption that is proportional to the frequency or its square is determined with Fourier integral technique. Variation in leading edge shape is obtained, and an experimental equipment is described, which records that shape for a sound pulse in air. This allows an indirect determination of the magnitude of sound absorption in air. G. Moretti, Argentina

5202. Leinard, P., Calculations of the low-frequency absorptions (in English), *Acustica* **8,** 2, 86–90, 1958.

Calculations of the low-frequency absorptions of the widely used perforated structures (whether continuous or in the form of bulkheads) are complex and difficult. For this reason author has set up abaci suitable for rapid calculation and general use. Tests of these now in hand are already showing good results. From author's summary

5203. Granholm, P., Sound insulation of single leaf walls, *Trans. Chalmers Univ. Technol.* no. 194, 48 pp., 1958.

Isolation afforded by simply-supported wall is reviewed. Effects of finite flexural rigidity and oblique incidence are investigated by approximating wall by vibrating beam. Total sound radiated from beam and its directional distribution are obtained in closed form by operational method for summing series. Maximum sound is radiated in direction predicted by coincidence effect. Beam treatment with finite rigidity indicates that, at low frequencies, sound pressure varies inversely with order of wall mode excited, so most radiation arises from gravest mode. With larger rigidity, deviations from mass law become more severe. At high frequencies mass law is approached closely for random oblique incidence. V. Salmon, USA

5204. Van Itterbeek, A., and Zink, J., Measurements on the velocity of sound in oxygen gas under high pressure, *Appl. sci. Res. (A)* **7,** 5, 375–385, 1958.

Using the acoustical interferometer for high pressures described in an earlier publication, authors measured the velocity of sound in oxygen gas between 1 and 70 atm as a function of pressure at different temperatures. From the experimental data they calculated the change of the ratio of the specific heats and the specific heats themselves as a function of pressure at the different temperatures. From authors' summary

5205. Gay, S. M., Jr., Modification of the disk-nose air-towed sonar housing, *David W. Taylor Mod. Basin Rep.* 1157, 13 pp. + 4 tables + 9 figs., July 1957.

Report is made of modification to the David Taylor Model Basin Disk-Nose Air-Towed Sonar Housing to satisfy requirements for a Naval Research Laboratory towing system. The major modification consisted of redesigning the lifting surfaces to provide a specified force and lift-drag ratio. The method used for the design is generally applicable, with certain reservations, to a large class of such problems. The modified fish was constructed by the Naval Research Laboratory and included pendulum-actuated roll-compensation devices to prevent "kiting." The fish was test-towed and found to be satisfactorily stable. From author's summary

5206. Yudin, E. Ya., The acoustic power of the noise produced by elements of air ducts (in Russian), *Akust. Zh.* **1,** 4, 308–382, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2891.

The results are given of an experimental investigation into the noise produced by a current of air flowing through a duct (elements

of air conduits of complicated form, low and high pressure ejectors, high-speed wind tunnels). The relationship is established between the acoustic power and the frequency spectrum of the noise owing to the pressure gradient in the air ducting, the geometric relationship, and the acoustic conditions. It is found that the acoustic power is proportional to the cube of the excess pressure, and the square of the geometric dimensions; the influence of the Reynolds number is insignificant. In the ducts investigated, noise covers an exceedingly large frequency range. The directional characteristic changes very little with variation of the pressure. Yu. A. Lashkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5207. Sretensky, L. N., The acoustic radiation of a rotating dipole (in Russian), *Akust. Zh.* **2**, 1, 93–98, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2754.

The axis of a dipole, the moment whereof varies periodically in time, is assumed to have a certain motion in space. Paper investigates the acoustic field of such a dipole when the aforesaid motion is either a uniform rotation or a harmonic variation of the angle of the dipole axis, maintaining a constant direction in space.

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5208. Maestrello, L., UTIA air duct facility for investigation of vibration noise induced by turbulent flow past a panel (boundary-layer noise), *Univ. Toronto Inst. Aerophys. TN* 20, 6 pp. + 2 tables + 11 figs., Apr. 1958.

An acoustically-quieted air-duct facility has been constructed for the purpose of investigating noise generated by turbulent flow past a flexible panel ("boundary-layer noise"). The facility is basically an open-circuit wind-tunnel with interchangeable 33-ft rectangular duct sections 12 in. wide and one, two, four and eight inches deep. The downstream end of the duct, where fully developed channel flow is obtained, contains the test panel, fitted flush in one wall. Maximum speed (4-in. duct) with the 10-hp blower is 200 fps. Details of design and aerodynamic performance—e.g., velocity profiles and pressure gradient—are given.

From author's summary

5209. **Zarembo, L. K., Krasil'nikov, V. A., and Shklovskaia-Kordi, P. P., The propagation of ultrasonic waves of finite amplitude in liquids** (in Russian), *Soviet Phys.-Acoustics* **3**, 1, 27–34, Dec. 1957. [Translation of *Akust. Zh., Akad. Nauk SSSR* **3**, 1, 29–36, Jan.–Mar. 1957 by Amer. Inst. Phys., New York, N. Y.]

The dependence of the absorption coefficient upon acoustic intensity (max. 5 w/cm²) was experimentally investigated at a frequency of 1.5 megacycles. For an intensity of ~ 4 w/cm² the absorption coefficient of ethyl and methyl alcohol and of toluene was hundred times higher than for very small amplitudes; other investigated liquids, e.g. water, transformer oil, acetic and formic acids, glycerine, showed a smaller increase. The absorption coefficient grows linearly with the amplitude of the acoustic pressure. Since measurements at an increased static pressure gave the same results, cavitation cannot be the cause of the rise of absorption. However, the experimental results are in a qualitative agreement with the theory of Fox and Wallace [AMR **9** (1956), Rev. 1292]. Margot Herbeck, Germany

5210. Merkulov, L. G., Absorption and diffusive scattering of ultrasonic waves in metals, *Soviet Phys.-Tech. Phys.* **2**, 5, 953–957, Feb. 1958. [Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **27**, 5, 1045–1050, May 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

Absorption and scattering of ultrasonic waves (5 - 180 mc/s) for wave lengths small compared to linear dimensions of grains are measured in aluminum, magnesium, iron. At very high frequencies losses due to thermal conductivity are observed. Agreement with theoretical considerations is satisfactory. Measurements of this kind permit the determination of average grain size in a metal.

F. E. Borgnis, USA

Ballistics, Detonics (Explosions)

(See also Rev. 5112)

5211. Sodha, M. S., and Jain, V. K., Internal ballistics of a high velocity light gas gun, *Appl. sci. Res.* (*A*) **7**, 5, 351–356, 1958.

Equations are set up for the gun described by Crozier and Hume [*J. appl. Phys.* **28**, p. 892, 1957] in which there is behind the shot a column of gas of low molecular weight. Propellant is taken to burn with quadratic form function and power law of pressure, and the later equations are specialized to tubular propellant. Equations are not valid after propellant is all burnt. Authors suggest that equations should be solved numerically but do not present any results.

Reviewer doubts whether anyone without an electronic computer will get an understanding of the behavior of this type of gun from this paper. J. Corner, England

5212. Jain, V. K., and Sodha, M. S., On the internal ballistics of a supergun (hochdruckpumpe), *Appl. sci. Res.* (*A*) **7**, 5, 369–374, 1958.

Equations are set up for a gun with propellant chambers leading into the barrel at various positions down its length, the propellant in each being assumed ignited as the shot passes and completely burnt before the next chamber is reached. Propellant burns with power law in pressure and quadratic form function. Analytical solution is presented for burning linear in pressure, and covolume equal to solid density. No numerical results are given.

J. Corner, England

5213. Paul, B., and Zaid, M., Perforation of a thin plate, *J. Franklin Inst.* **265**, 4, 317–335, Apr. 1958.

Thin plate perforation theory for projectiles with conical noses [AMR **11** (1958), Rev. 852] is extended to truncated ogival and conical projectiles. Theory gives velocity-distance relation and forces during perforation. Experimental velocity drops give order of magnitude check. Normal incidence only is used.

J. Corner, England

5214. Gibson, F. C., Bowser, M. L., Summers, C. R., Scott, F. H., and Mason, C. M., Use of an electro-optical method to determine detonation temperatures in high explosives, *J. appl. Phys.* **29**, 4, 628–631, Apr. 1958.

A method has been devised for sampling the optical radiation from the interior of a detonating solid-explosive charge by introducing a transparent plastic rod axially into the charge at the time of fabrication. The radiation was analyzed by a grating spectrograph, using four bands 100 A wide and 600 A apart. The radiation intensities were used to calculate the color temperatures within the detonating explosive. The apparatus was calibrated by a radio-frequency-excited lamp known to have gray-body radiation. The explosive charges were vacuum-impregnated with propane to replace the air in the intergranular voids to eliminate light emission from the air shock. From authors' summary

Soil Mechanics, Seepage

(See also Revs. 4886, 4959, 4996, 5221, 5224, 5233)

Book—5215. Prickl, G., Deep-boring tools with particular regard to rotary-boring sets (Tiefbohrgerate mit besonderer Berucksichtigung der Rotary-Bohranlagen), Wien, Springer-Verlag, vii + 305 pp. $11.45.

Book gives first an account and a classification of the resistance values of various rocks and soils as a function of boring velocity and states that the time required is dependent not so much on the hardness as on the way of bonding of the constituting minerals. Then it gives an historical survey of the development of boring devices from the famous well borings in Artois (France, 1940) up to the present time of rotary-boring with the newest turbine propulsion.

Author strives to give a detailed description of the main methods of deep-boring through the detailed presentation of the single elements of the equipment. At first he deals with *hand-boring*, then the mechanically operated *rotating boring method.*

Then follows a description of *percussion-boring*: Form and material of augers, chisels, rod ropes, winches, flushing-pumps, calculation of energy consumption; dimensioning and applicability of the single elements, their material and operation methods, with detailed and tabulated data of boring efficiency.

The most detailed description is given for the *rotary method.* Beginning with the construction of the boring towers and of the hoisting machinery (chain and rope structure), the author gives a very clear review of the revolving table, flushing-pumps, and even of the steam engines serving the propulsion; also theoretical details of the mechanical equipment and gears. This is completed by a very detailed presentation of the bore heads and the drill stems, with their detailed standard dimensions in tables. The dimensioning and the calculation of required pressure is illustrated by numerical examples, and the efficiency with cost and comparative data of various products. Finally, author sums up the development attained to date and concludes by indicating its further possibilities.

The book is very useful for all those interested in the execution and technique of practical deep-boring jobs (search for oil, coal, minerals, etc.) and gives very useful information on the construction and operation of all mechanical devices, but is not meant for soil investigation whatsoever. No reference is made to the evaluation of samples or to sampling in general and to the determination of the stratification. E.g., the up-to-date electropotential method "carrottage" is also not presented.

C. Szechy, Hungary

5216. Sokolovsky, V. V., Some discontinuous solutions in soil mechanics (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **8,** 112–118.

As an introduction, paper presents the general equations of plane limiting equilibrium of an earth mass having internal friction and cohesion, taking into account the weight. The main system of equations is of a hyperbolic type and has two families of real characteristics. Author deals with the construction of the limiting contour of a stable semiarch, the lower part of which is a slope. Along the horizontal boundary a uniformly distributed normal pressure is acting. If at the upper point of the semiarch the angle of the tangent to the contour line is given, the solution furnishes a line in the interior of the semiarch, above which the simplest stress field prevails, but along this curve the interior component of the normal stress is discontinuous. Between this curve and the free contour line the stress field can be determined by numerical integration of differential equations of the characteristics. In the special case of $p = 0$ a solution in closed form could be given. Using the solution of the semiarch it is possible to determine the limiting contour of a stable arch which consists of two identical semiarches. The contact stresses acting on the curvilinear contour of this rigid wall have been calculated with the consideration of the particular cases of $\delta = 0$ and $\delta = \phi$. In the latter case an approximate formula is given. For the special cases of cohesionless and weightless soils and for straight boundaries author obtains the known formulas. The results are very simple, if $\phi = 0$.

A. Kezdi, Hungary

5217. Seed, H. B., McNeill, R. L., and de Guenin, J., Increased resistance to deformation of clay caused by repeated loading, *Proc. Amer. Soc. civ. Engrs.* **84,** SM2 (*J. Soil Mech. Found. Div.*), Pap. 1645, 29 pp., May 1958.

The influence of stress history, in the form of a series of repeated stress applications, in increasing the resistance to deformation of compacted specimens of silty clay is described and possible causes of the effect are presented. The significance of the results in assessing the design life of highway pavements is discussed.

From authors' summary

5218. Linevsky, A. A., The problem of correct determination of the static shear stress in clay puddle (in Russian), *Neft. kh-vo* no. 4, 16–21, 1954; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3323.

An instrument is described for determining the limiting shear stress in clay suspensions, which consists of two concentric, rotating cylinders between which the clay puddle is made to flow. The limiting shear stress is determined from the deflection of the cylinders at the beginning of the flow of the puddle. The author points out that the instrument exhibits errors, rising to as much as 200%. The latter circumstance is explained by the fact that it is impossible to determine accurately when the suspension begins to flow. In the author's opinion, the shear stress value determined by this instrument does not correspond to the limiting shear stress obtained by the Bingham formula.

Author consequently suggests to determine the limiting shear stress by an apparatus consisting of a rubber U-tube which is filled with the suspension, and to one end of which a water-filled glass tube is attached. The limiting shear stress is then determined by the pressure of the water column in the glass tube. Experiments made by the author indicate that the error with this instrument does not exceed 5%.

G. N. Pykhteev

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

5219. Nishida, Y., The calculation by approximation of the strength of a group of pilings (in German), *Bautechnik* **34,** 11, 436–439, Nov. 1957.

On assumption of elastic-isotropic medium author derives expression for bearing capacity of pile groups in cohesionless soils. Basic assumptions of constant modulus of elasticity and Poisson's ratio are incompatible with actual behavior of cohesionless materials, especially at state of failure. For usual pile lengths, present theory gives bearing capacity values approximating those according to the Benabencq method, which is known to be unreliable.

G. G. Meyerhof, Canada

Book—5220. Evdokimov, P. D., The strength of foundations and the stability of hydraulic engineering structures in soft soils (in Russian), Moscow, Leningrad, Gosenergoizdat, 271 pp. + illus., 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3567.

The book contains the results of theoretical and experimental investigations made with the object of evaluating different methods for calculating the strength of foundations on soft (nonclearing) foundations, and the stability of structures erected thereon.

A critical evaluation is given of a number of methods, such as those developed by G. E. Paucker, K. Tertsagy, S. I. Belzetsky, N. M. Gerservanov, M. M. Grishin, S. S. Golushkevich, V. I. Novotortsev, and others.

On the basis of analytical and experimental data, a practical method of calculation is suggested which represents a development of the method of V. I. Novotortsev. The improvement consists in that the assumption of the possibility of the transfer of weight of the slip prism to the foundation surface, in the form of a uniform load, is discarded. The problem is solved by methods of graphic analysis, without consideration of the inherent weight of the foundation and in the absence of filtration forces; and also by an analytical method, which leads to determinate formulas for the weights of the individual regions of the slip prism, and for the critical loads of the foundation. The author comes to the conclusion that the approximate calculations of the volumetric forces produce results which do not agree with the experimental data and the more rigorous, analytical methods.

A great part of the book is devoted to the methodology and technique of determining the strength characteristics of soils, and a description of the instrumental equipment for this purpose.

The results are given of the results of numerous field and laboratory tests and experiments, made in the Soviet Union, both by the present author and by other persons. These investigations consisted in determining the relationship between the normal and the tangent (shear) components of the pressure on the foundation, by the structure in slipping, and measuring the deformations of sandy and stratified foundations of such structures.

It is noted that calculations of the strength of foundations on the basis of the theory of elasticity lead to a reduction of the calculated carrying capacity by comparison with the true or actual value. The bibliography of 45 titles contains no foreign (i.e. non-Russian Transl.) literature.

G. K. Klein

Courtesy Referativnyi Zhurnal, USSR
Translation, Courtesy Ministry of Supply, England

Micromeritics

(See also Revs. 4873, 4874, 4958)

5221. Dardaganian, S. G., The application of the Buckley-Leverett frontal advance theory to petroleum recovery, *J. Petr. Technol.* **10,** 4, 49–52 (Tech. Note), Apr. 1958.

The fractional-flow equation of Leverett [*Trans. AIME* **142,** p. 107, 1941] and the frontal-advance equation of Buckley and Leverett [*Trans. AIME* **146,** p. 107, 1942] were used in the calculation of recoveries for two types of oil reservoir drives: drive by gas-cap expansion and drive by water invasion. No new technology is presented, although the examples described illustrate nicely the use of these equations in reservoir behavior calculations.

S. R. Faris, USA

5222. Amenzade, Yu. A., and Azimov, B. A., The inflow of petroleum to boreholes in a stratum of curvilinearly-square form (in Russian), *Trudi Azerb. in-ta po dobyche nefti* no. 2, 118–126, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3276.

An approximate solution is given for the problem of the inflow of petroleum to a borehole (or system of boreholes) in a stratum with a square feeding profile, in which a constant pressure is assumed. The approximating, conformal representation of the interior of the circle on the interior of the square is presented in the form of a polynomial as the sum of four addenda of the series expansion of the corresponding Christoffel-Schwartz integral.

The formulas for the discharge volumes of single boreholes or systems of boreholes are determined by known methods. Curves are given of flow volumes calculated by the methods suggested; and comparisons are made with the analogous values for a circularly-delimited stratum, the contour whereof is inscribed in, or circumscribed around, a curvilinearly-square contour.

V. P. Pilatovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5223. Khakivo, M. Kh., The influence of the change in viscosity of gas-laden petroleum oils in relation to the pressure, on the output of boreholes (in Azerbeidj.), *AzerbSSR elemler Akad. kheberleri* no. 4, 47–49, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3277.

The inflow to a borehole of gas-laden petroleum is investigated for the case where the pressure in the heading is higher than the saturation pressure. The viscosity of the petroleum, μ, is assumed to be represented in terms of the pressure P by the expression

$$\log \mu = \log \mu_s + \alpha(P - P_s)$$

(P_s = saturation pressure; μ_s viscosity of the petroleum at this pressure; α a coefficient, constant for the particular petroleum and pressure). Integrating, for varying values of μ, the equation of the inflow of petroleum to the borehold, author obtains the following expression for the delivery volume of the borehole

$$Q = \frac{2\pi kb(P_k - P_c)}{\mu_\Phi \ln R_k/R_c} \qquad \left(\mu_\Phi = \frac{2.30\mu_k\mu_c}{\mu_k - \mu_c} \lg \frac{\mu_k}{\mu_c} \right)$$

(k coefficient of filtration; b thickness of the stratum; the indices k and c represent the ratio of the values to the cross sections at distances R_k and R_c from the axis of the borehole). Values are stated for μ_Φ in terms of the values of the parameters μ_k/μ_c.

V. A. Arkhangel'skii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5224. Leczfalvy, S., Determination of the yield of galleries (in Hungarian), *Hidrológiai Közlöny* **38,** 1, 21–23, Feb. 1958.

Previously title problem was determined by Dupuit formula. Author presents new method taking into account the percolation also. It deals with the rules of evaporation from, and percolation into, groundwater and with the level where these are balanced (called equilibrium groundwater table). Author assumes that percolation below the equilibrium level (also average groundwater level) varies linearly in case of small drawdowns, and gives the equation $Q = (ak/0.66\, y_0^3 - Hy^2 + 0.33H^3/)^{1/2}$ where a is excess percolation into groundwater per unit area in case of drawdown of 1 meter, k permeability, H head of groundwater, $y_0 = H - s$, where s is the drawdown. Equation is based on laminar flow and horizontal lower impermeable layer.

Reviewer believes that author's method is correct, but the long-time recording of annual variations of difference between evaporation from groundwater and percolation into it, plotted against the depth of groundwater table, may hardly be obtainable in actual cases.

A. Simon, USA

5225. Babanov, A. A., Methods for calculation of thermal conduction coefficients of capillary-porous materials, *Soviet Phys.-Tech. Phys.* **2,** 3, 476–484, Mar. 1957. [Translation of *Zh. tekh. Fiz. Akad. Nauk SSSR* **27,** 3, 532–542 by Amer. Inst. Phys., Inc., New York, N. Y.]

Author says that the most realistic structure for a disperse system turns out to be the tetrahedral structure, based on the principle of closest packing of the particles, and also that equation given in a previous paper by Bogomolov and based on this structure seems to agree with experimental data.

In fact, in the unique and simple case examined (dry quartz sand of unknown dimension of particles) the errors of calculated data are of 20 to 50%.

C. Codegone, Italy

5226. Taylor, G., Steady flow of a fluid entering a region through porous boundaries (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles 1957; **2**, 88–95.

The deposition of a film of liquid onto a smooth surface from a porous solid rubbing against the smooth surface is analyzed mathematically for various boundary conditions.

The integral equation for thickness of a wet porous sheet held briefly against a suction wheel is given, and a recent solution by G. F. Miller is referred to. In this case, the inertia of the liquid is included but the viscosity neglected. The equation and solution for the case of viscosity appreciable and inertia negligible are also given.

Applications of the theory to painting rolls and paint brushes are discussed. A large-scale model of an idealized brush is also studied and found to agree with the theory within some 10%.

It is shown that for a thin film to be spread by circumferential drag the fluid must reach the surface being painted through narrow passages, and the supply to those passages must not involve appreciable suction at places where air could enter.

C. F. Bonilla, Puerto Rico

5227. Rosenberg, M. D., The gas factor in the transient filtration of gas-laden petroleum (in Russian), *Trudi Vses. neftegaz. n.-i. in-ta* no. 8, 320–322, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3283.

Proof is given that the gas factor in the transient filtration of gas-laden petroleum must necessarily change its value along the line of flow. This demonstrates that the proposition incorporated in the (existing) method of exchanging steady states, that the values of the gas factor are invariable in each analytical time instant, is merely an assumption; in the rigorous formulation, the gas factor should be considered as fluctuating little in time or distance.

V. A. Arkhangel'skii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5228. Ponomarev, V. D., and Nee, L. P., The relationship between specific resistance to filtration, particle diameter, and porosity (in Kazak), *Izv. Akad. Nauk KazSSR* no. 118, 3–10, 1953; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3287.

An analysis is made of the equation of the unit specific resistance of a fictitious soil (consisting of spherical particles): $r = k(1-\epsilon)^2/d^2\epsilon^3$, where k is an experimental coefficient, ϵ the porosity, d the diameter of the particle(s). The applicability of this equation is verified for deposits formed of undistorted particles of arbitrary shape. The experiments were made in a vacuum, using a filter with a filtering partition of porous glass (surface area of filtration, 107 cm²). The values of r calculated for the duration of filtration of a determined volume of liquid through a layer of deposit of constant thickness under pressure are given. It is found that the relationship of r to d and ϵ for deposits of quartz and galenite (galena) reproduces the above equation with sufficient accuracy. It is further found that a similar relationship for precipitates of alumina and iron oxide is sufficiently expressed by the equation

$$r = k'(1-\epsilon)^{4.5}/d^{1.6}\epsilon^3.$$

It is demonstrated that a less intensive increase in r with decreasing d and ϵ for precipitates of alumina and iron oxide, compared with deposits of quartz and galena, can be explained by the greater porosity of the structure of the first-named.

V. A. Zhuzhikov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5229. Shestakov, V. M., The determination of the seepage coefficient of anisotropic strata by pumping tests (in Russian), *Razvedka i okhrana nedr.* no. 6, 52–55, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3290.

A method is presented for determining the seepage coefficients of anisotropic strata from pumping tests with two observation bores, located on radii coinciding with the principal directions of anisotropy. The derivation of the method is founded on the known principle of reducing an anisotropic soil to the isotropic equivalent by means of corresponding deformation of the seepage region. In this regard, the cross section of the bore from which the pumping is performed becomes of elliptical shape, and the author, consequently, applies the relationship for the inflow to an elliptical borehole. A practical example is given of calculating the seepage coefficients for an anisotropic soil.

V. I. Aravin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5230. Idelchik, I. E., Flow distribution as a means of increasing the efficiency of electric filters (in Russian), *Koks i khimiya* no. 1, 47–54, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2890.

5231. Ogilvi, A. A., Seepage location by electrical measurements (potentiometry of natural electric currents) (in Russian), *Gidrotekh. Stroit.* **26**, 12, 31–34, Dec. 1957.

5232. Voshchinin, A. P., Simplified method of seepage computation through earth dams (diagrams for reduced discharges in uniform soils) (in Russian), *Gidrotekh. Stroit.* **26**, 8, 34–36, Aug. 1957.

5233. Ollos, G., A detailed investigation into hydraulic conditions around well mantle (in Hungarian), *Hidrológiai Közlöny* **38**, 1, 1–20, Feb. 1958.

Author's new hydraulic model has made it possible to obtain new information on the system of flows entering into wells. The mantle of the model well was divided horizontally into separate parts by sloping baffle plates in order to obtain the distribution of velocity and the yield along the well mantle. Water quantities entering the well model from the capillary layer and from the seepage area above and under the water level of the well have been measured separately.

Results: (1) The trend of discrepancy between theoretical and observed drawdown curves is given. At greater drawdown the Dupuit theory cannot be used except for approximation of curves. (2) As to the difference between water levels outside and inside of the well mantle, h_k and h_b respectivelv, investigation indicated the following approximative relationship: $h_k - h_b = (535\, r_0^{-1})^{1/50} \cdot (H - h_b)^3 \cdot H^{-1}$. (3) The Dupuit theory can be used reliably for calculating the yield. Maximum of yield at $h_b = 0$. (4) Vertical distribution is given for yield and velocity at different drawdowns. (5) Graphs are given on discrepancy between seepage velocities computed for h_k and h_b plotted against different drawdowns.

Reviewer believes that application of author's model-splitting method would be worthwhile for other hydraulic experiments also.

A. Simon, USA

5234. Ollos, G., Investigation of flow phenomena around wells (in Hungarian), *Hidrológiai Közlöny* **37**, 1, 26–32, Jan.–Mar. 1957.

5235. Vessey, E., and Czerny, G., Underground flow study by isotopes (in Hungarian), *Hidrológiai Közlöny* **37**, 1, 44–46, Jan.–Mar. 1957.

5236. Filchakov, P. F., Grapho-analytical method of seepage computation (in Russian), *Gidrotekh. Stroit.* **25**, 10, 43–50, Oct. 1956.

5237. Nelson-Skorniakov, F. B., Seepage through a dam with drainage sill on impermeable and permeable foundation (in Russian), *Gidrotekh. Stroit.* **25,** 5, 28–30, May 1956.

5238. Kereselidze, N. B., Computation of sedimentation tanks in continuous hydraulic scouring (in Russian), *Izv. Tbilissk. n.-i in-ta sooruzb. i gidroenerg.* **9,** 18–29, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 539.

The problem of the fall-out of the particles of sediment in the sedimentation tanks in continuous hydraulic scouring is examined by two methods: computation by the boundary fraction of the settling sediment and computation by a given turbidity.

Kh. A. Navoyan

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5239. Culverwell, J. F., Grounds, P. W., Jr., Lamb, G. G., and Stevens, W. F., Composition change in binary-component spray vaporization at atmospheric pressure, *AIChE J.* **2,** 4, 555–560, Dec. 1956.

Author investigates factors affecting change of composition with vaporization of a binary component spray in heated air at atmospheric pressure. System orthodichlorobenzene-tetrachloroethylene was studied in air ranging from 400 to 1000 F, with drop diameters in the 20 to 400-micron range. Experiments indicated that rate of change of spray composition during vaporization was affected only by chamber-air temperature, the initial composition, and the nozzle characteristics. Mathematical expressions for the vaporization process are presented, liquid diffusion being assumed within the drop controls; these equations have been solved by stepwise procedures for three initial drop sizes. Statistical calculations are used to predict the vaporization behavior of the spray. The calculations agreed with previously obtained experimental data for the initial portion of spray travel from nozzle to tray; for subsequent portion of spray considerable deviation was found. Further experiments are needed to determine more precise values for drop-size distribution, initial drop velocity, and liquid diffusion coefficient. Experimental equipment and technique are described in detail, data of an experiment are tabulated, and sample calculations are carried out. K. J. DeJuhasz, Germany

5240. Browning, J. A., Production and measurement of single drops, sprays, and solid suspensions, New York, Amer. Chem. Soc. (Advances in Chemistry Ser. no. 20), 1958. 136–154.

Experimental investigation of the combustion of sprays is complicated by the many variables involved. Sprays are composed of a wide range of drop sizes distributed unevenly within the spray cone. Turbulence of the air and relative motion of the drops through the air are inadequately defined, yet play an important role in combustion. The burning of an isolated drop presents a difficult problem, which, however, has been clarified to some extent in recent years. To study the effect of any single variable on the combustion of spray, other variables must be kept constant.

This paper reviews spray literature under two main headings: (1) production of drops and sprays, and (2) size measurement of both single particles and sprays (including uniform clouds of drops and solid suspensions).—Under the heading "Production" are treated: single drops and streams of uniform drops and their change through evaporation; spinning disk atomization; pressure atomization; airstream atomization, and impinging jets; aerosol generation; and solid suspensions. Under the heading "Measurement" are treated: mechanical methods including collection on slides, jet impaction, sedimentation, elutriation, centrifugal separation, momentum and mass flow measurement; physicochemical methods including freezing of drops, evaporation, wax method, thermal precipitation, and gas adsorption; optical methods including photographic and diffraction techniques; electrical methods; size-distribution expressions; particle shape; flow of suspended particles; aggregation of particles; static electrification of dust particles; droplet internal circulation.

For all these headings and subheadings the most important recent literature is cited. K. J. DeJuhasz, Germany

5241. Hauschild, W., Spraying process for generating hollow spheres without dust (in German), *Seifen-Ole-Fette-Wachse* **26,** 5 pp., Dec. 1955.

Paper concerns manufacture of heavy-duty detergents and light-duty detergents in the form of "beads." Description of spraying equipment, preparation of drying air, construction of spray tower, drawing off of exhaust air, and recovery of fine dust are included. Merits and disadvantages of sack filters and wet separators are compared with cyclone separators, co-current and counter-current drying air. Properties of products and their variations are indicated. K. J. DeJuhasz, Germany

5242. Ranz, W. E., On sprays and spraying, Dept. Engng. Res. Penn State Univ. Bull. 65, 75 pp. + 20 figs., 1956.

Survey evaluates and interprets present-day information on sprays for research and development engineers concerned with the science and technology of sprays. Spray phenomena involve complicated physical processes influenced by many variables. The survey is organized under three headings:

I. Characteristics of sprays, including: drop sizes, representation of size distributions, sampling and sizing methods for measuring drop sizes, rapid sizing methods, and standardizing test methods for drop sizes;

II. Mechanics of drops and sprays, including: mechanics of single drops, terminal velocities, acceleration and deceleration of single drops and ultimate stopping distance, impaction of drops, and definition of dispersion and penetration;

III. Important variables affecting breakup of jet, including: surface tension, viscosity, liquid sheets, liquid filaments, gas atomization, dimensional analysis of quantities governing spray phenomena, and evaluation of theories concerning jet breakup.

The text is clarified by numerous charts and equations.

This survey provides a logical framework for the study of spray phenomena within which other information can be systematically organized. K. J. DeJuhasz, Germany

5243. Jung, R., Pressure drop in the inlet region of pneumatic conveyor pipe lines (in German), *Forsch. Geb. Ing.-Wes.* **24,** 2, 50–58, 1958.

In the pneumatic transport of granular solids through pipes there is required, besides the pressure drop resulting from wall friction, an additional pressure drop. This additional pressure drop consists of three parts: (a) an impulse part needed to accelerate the solid particles, (b) a static part for the transport of the solids through the conveyor pipe, and (c) a part required to overcome the friction between the walls of the conveyor pipe and the solid particles. This additional pressure loss in the conveyor pipe was calculated under conditions which assumed (c) to be negligible, and compared with the experimental results for cast iron spheres in vertical, horizontal, and inclined pipes. For horizontal pipes and for pipes inclined approximately 30° with the horizontal, the deviation between experiment and theory was within the experimental error. For vertical pipes, the measured values were approximately 6% larger than the calculated values.

If the stream density in the conveyor pipe exceeds a certain critical value for a given pipe and for a given air velocity the conveyor operation fails. This critical value is determined by the average inter-particle distance at the point where the particles enter the conveyor pipe. S. A. Faris, USA

5244. Arabadzhi, V. I., Kinetics of the collision of drops (in Russian), *Meteorol. i gidrologiya* no. 4, 35–36, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 449.

5245. Patterson, R. C., Pulverized-coal transport through pipes, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-24, 17 pp.

5246. Kovacs, L., and Toth, J., Experiments and results on pneumatic transportation of pulverized materials (in Hungarian), *Gép* **10,** 2, 59–66, Feb. 1958.

5247. Fainzil'ber, A. M., Some mathematical questions on the aerodynamical separation of a mixture of grains (in Russian), *Dokl. Mosk. c.-kh. Akad. im. K. A. Timiryazeva* no. 22, 412–414, 1956; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2094.

Geophysics, Meteorology, Oceanography

(See also Revs. 5070, 5071, 5072, 5073, 5074, 5078, 5106, 5142, 5205, 5265, 5276)

5248. Napetvaridze, Sh. G., Hydrodynamic pressures in seismic action (in Russian), *Trudi in-ta stroit. dela Akad. Nauk Gruz. SSR* **5,** 123–139, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3031.

The fluid is assumed to be ideal (perfectly) and incompressible. The flow is two-dimensional. The depth of flow is constant. The problem of the impact of a flow on a vertical dam has been analyzed by Westergaardt with the help of series expansion [*Proc. Amer. Soc. civ. Engrs.* **57,** 1931]. The present author attempts to generalize Westergaardt's solution of the problem for the case of an inclined dam. Author's solution is, however, faulty. With the exception of Westergaardt's limiting case ($\alpha = 0$), the velocity potential φ [Eq. 20] does not satisfy the continuity equation $\overline{V}^2\varphi = 0$. [Eqs. 16] and [17] determine the partial derivatives $\partial\varphi/\partial x$ and $\partial\varphi/\partial y$ in such manner that at $\alpha \neq 0$, the identity

$$\frac{\partial^2\varphi}{\partial y \partial x} = \frac{\partial^2\varphi}{\partial x \partial y}$$

is not satisfied.

A group of analogous problems and, in particular, Westergaards's problem, have already been solved by methods of the theory of functions of a complex variable by L. S. Ivanova.

M. I. Gurevich

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5249. Ghul', K. K., Ocean swells (in Russian), *Uch. zap. Azerb. un-ta* no. 1, 53–66, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 563.

Author comes to the conclusion, after sorting out the material from more than 6600 investigations on the elements of wave formation in in-shore areas, that empirical formulas for calculating such elements cannot be standardized to cover all regions and cases. The existing scale for converting wind velocity to wind force α (in points) and also to wave force b (in points) for coastal sea areas, in the view of the author, does not satisfy the actual correlation between wind and wave. Different data are presented for the wave parameters in relation to wave velocity. It was found that the relationship of the velocity of the fully established waves c to the wind velocity V constitutes 0.5–0.25. The article contains a number of unsubstantiated assertions and obscure formulation.

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5250. Tsikunov, V. A., The theory of the formation of a layer of temperature discontinuity in the sea (in Russian), *Trudi Gos. Okeanograph. in-ta* no. 29, 92–106, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3090.

The decisive influence of convection on the thermal regime of the superficial layer of the sea is demonstrated; in particular, the influence on the formation of a discontinuity layer. Quantitative evaluation of the influence of convection turbulent exchange in the stratum of convective-wind mixing is performed by means of a system of linearized equations of the theory of convection in application to solenoids, formed by wind currents in the sea. The solutions of the said system for the initial stage of the process, of the formation of convective nuclei, are based on the assumption that, in general, this stage resembles the condition of steady motion. The expressions for the projection of the velocity u, w, and the temperature ϑ in the layer contain a constant multiplier B which cannot be determined within the limits of a linear theory. For its determination an additional assumption is introduced, that the quantity of heat introduced at the surface of the sea, besides that heat which is necessary to maintain the temperature gradient in the layer, is completely dissipated within that layer. It is found that B is proportional to $\sqrt{\beta - \beta_{cr}}$ (β, β_{cr} the existing and critical temperature gradients, respectively. Furthermore, an equivalent coefficient of temperature conductivity, $\chi_{ek} = \chi + \chi_k$, is introduced, in which χ is a coefficient representing the equilibrium condition, and χ_k a "convection coefficient" determining the vertical influx of heat, $\Pi = \rho C_p \chi_k \beta$. Author obtains an expression for χ_{ek} containing the parameter b. This cannot be determined within the limits of the developed theory. Consequently, author correlates the theoretical calculations with experimental data and arrives at the following approximate formula

$$\chi_{ek} \sim \chi \left[1 + \frac{8.4 \cdot 10^3}{H}\left(\frac{GP}{(GP)_{cr}} - 1\right)\right]$$

wherein H is thickness of the layer, G and P the Grashoff and Prandtl numbers of the liquid in question. P. S. Lineikin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5251. Roberson, R. E., Air density determination by observation of a satellite, *Jet Propulsion* **28,** 5, 330–331, May 1958.

Previous results on the relationship between orbital eccentricity and radius for a satellite affected by air drag are applied to the problem of inferring air density as a function of altitude.

From author's summary

5252. de Jong, H. M., Errors in upper-level wind computations, *J. Meteor.* **15,** 2, 131–137, Apr. 1958.

Author considers three classes of upper-level wind observation techniques, namely, height-elevation, range-elevation, and range-height. Equations are derived for random errors in each of the three methods due to errors in azimuth, elevation angle, slant range, balloon height, and time. Computations show all methods give comparable results for wind speed for the balloon at relatively short distances from the station, but range-elevation and range-height techniques are much superior for large distances from the station (greater than 20 km).

Effect of ascent rate and time interval on magnitude of errors is also considered, with author concluding that errors can be reduced by increasing time interval or ascent rate or both. Unfortunately, this obviously would also reduce the number of points of wind-velocity observation in any given atmospheric layer.

N. K. Wagner, USA

5253. Bushnell, R. H., and Huss, P. O., A power spectrum of surface winds, *J. Meteor.* **15,** 2, 180–183, Apr. 1958.

Paper presents a power spectrum of surface winds, developed as part of a study on flight control design. The spectrum, derived by a simple method of calculation, extends from 10^{-5} cps to 1 cps. Over much of this band it has the form $af^{-1.4}$.

From authors' summary

5254. Arnason, G., A convergent method for solving the balance equation, *J. Meteor.* **15,** 2, 220–225, Apr. 1958.

The nonlinear balance equation is replaced by an infinite system of linear differential equations. This system has a series of solutions which, under certain conditions, converge toward the solution of the balance equation. It is shown that these conditions coincide with the conditions for ellipticity of the balance equation.

A slightly different method of solution is shown to diverge. This is illustrated by a case where the sequence of approximate solutions is compared with the solution of the balance equation.

From author's summary by N. K. Wagner, USA

5255. Alaka, M. A., A case study of an easterly jet stream in the tropics, *Tellus* **10,** 1, 24–42, Feb. 1958.

An easterly current at 200 mb over the Southern Bahamas and Florida is identified as a jet stream which had originated in middle latitudes and had travelled along the eastern periphery of the dynamic anticyclone situated over the South Eastern United States. The properties of this current are studied and compared with those associated with middle latitudes jet streams. It is found that although this current is comparatively weak (core velvelocity about 70 kts), horizontal and vertical wind shears near its axis are comparable with those observed near the usually much stronger middle latitudes jet streams.

The mechanism responsible for the concentration of the kinetic energy in this narrow current is shown to be independent of any temperature contrast between two air masses in the lower and middle troposphere. The jet is further shown to be maintained by pressure heads and the continuous production and destruction of kinetic energy involved in its maintenance and motion occur as a result of accelerations in more or less laminar flow rather than by lateral or frictional stresses. Finally, the observed weather distribution is found to be influenced by the resonance and interference of the upper jet stream with waves in the lower easterlies.

From author's summary

5256. Kuo, H.-L., Further studies of thermally driven motions in a rotating fluid, *J. Meteor.* **14,** 6, 553–558, Dec. 1957.

Paper is an extension of earlier work by author [*J. Meteor.* **13** (1956), 81–101; 521–527] concerning the theory of transitions from one regime to another in motions produced by horizontal differential heating in rotating fluids. The lower Hadley symmetric regime, the wave regime, transitions within the wave regime, and the upper Hadley symmetric regime are treated mathematically. Implications from the theory are compared with experimental results obtained by Fultz [see also AMR **9** (1956), Rev. 898].

R. O. Reid, USA

5257. Michel, V. M., The problem of the motion and intensity variation of barographic regions (in Russian), *Trudi Gl. geofiz. observ.* no. 56, 59–68, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3252.

The problem of the displacement of mobile cyclones and anticyclones is examined from the aspect of utilizing, in prognostical work, the rule of the guiding current. The altitude of the boundary of the guiding current is determined; the altitude is indicated at which, in the opinion of the author, the guiding current best characteristizes the displacement of the barographic translations. Other known empirical rules are stated, equivalent to the rule of the guiding current.

The results are also examined of verification of the rule of convergence and divergence, of winds at altitudes, for the prediction of the evolution of baricenters.

K. G. Abramovich

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Lubrication; Bearings; Wear

(See also Revs. 4981, 4985)

5258. Kingsbury, E. P., Some aspects of the thermal desorption of a boundary lubricant, *J. appl. Phys.* **29,** 6, 888–891, June 1958.

Paper is concerned with friction that occurs in the transition state going from boundary-lubricated to clean sliding. Starting with an idealized model of a sliding system, author arrives at a relation in which the coefficient of friction f, in a boundary-lubricated sliding system, is expressed by a single exponential function of sliding velocity v and a double exponential function of absolute temperature T and of the heat of adsorption E. When f is plotted against T at constant v, and second, against v at constant T, is it seen that the limiting values of f are the friction coefficient f_m in the absence of any lubricant, and the friction coefficient f_f, when protection by the boundary film is perfectly and completely assured.

Experiments made with a sliding system, where any possibility of hydrodynamic lubrication is prevented, are related. Good agreement with the theory is found, although a slight modification of one of the relations leading to the final exponential equation is proposed.

It is shown in a final discussion that results obtained by other experimenters are in qualitative agreement with the proposed exponential equation. The possibility is put forward that the effect of temperature and velocity for boundary lubrication may be caused by a "quasi-hydrodynamic" lifting action produced by small pockets of bulk lubricant trapped between the rubbing faces.

D. DeMeulemeester, Belgium

5259. Kotova, L. I., Theory of the rolling of a cylinder on a surface covered with a layer of a viscous-plastic lubricant, *Soviet Phys.-Tech. Phys.* **2,** 7, 1424–1441, June 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27,** 7, 1540–1557, July 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

The Bingham equation is integrated for the case of a cylinder rolling on a curved surface. From this the load-carrying capacity of the layer of viscous-plastic lubricant is calculated, and also the power expended in overcoming the force of friction in the lubricant film during rolling.

R. Schnurmann, England

5260. Kotova, L. I., and Deriagin, B. V., Theory of a cylinder rolling on a surface covered with a layer of plastic lubricant, *Soviet Phys.-Tech. Phys* **2,** 6, 1154–1164, Feb. 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27,** 6, 1261–1271, June 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

The rolling of a cylinder on a curved surface which is covered with a layer of incompressible, ideally plastic material is considered. The pressure distribution is calculated for the case that the shear stress depends exponentially upon pressure, and from this the minimum film thickness for hydrodynamic flow is assessed.

R. Schnurmann, England

5261. Deriagin, B. V., Karasev, V. V., Zakhavseva, N. N., and Lazarev, V. P., Mechanism of boundary lubrication and the properties of the boundary lubrication film, *Soviet Phys.-Tech. Phys.* **2,** 5, 980–988, Feb. 1958. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27,** 5, 1076–1086, May 1957, by Amer. Inst. Phys., Inc., New York, N. Y.]

Authors claim that the principal mode of action of a boundary lubricant arises from its molecular interaction with the friction surface. This interaction modifies the physical properties of the lubricant. Two concepts of boundary lubrication are contrasted; that attributed to Bowden which is based on the assumption that only the properties of the surface and of a monomolecular film absorbed thereon affect, to a significant extent, boundary lubrication behavior, and that of Russian workers who consider that the effect of the solid wall may extend into a liquid containing polar molecules to a depth of many molecular layers.

The paper reviews evidence in favor of the latter point of view with particular reference to the "blow-off" test. In this test, a film of liquid was applied to one of the walls of a plane-parallel slit and viscous flow therein was induced by directing an even flow of air through the slit. At any given time, the profile of the film was a measure of the velocity of flow at the various distances from the interface and therefore of the local viscosity. A Newtonian liquid would therefore assume a wedge shape and this was shown to be the case with a nonpolar vaseline oil. The addition of small amounts of polar substances to this oil, however, caused a modification to the profile. Amyl acetate on a steel plate showed a marked increase in viscosity up to a distance of 150$\mathring{A}$ from the plate, but dibutyl phthalate and an incompletely hydrated benzanthene film indicated lowered viscosities in the immediate vicinity of the interface. Authors suggest that the stability of the orientation effects is developed by the deformation consequent on laminar flow and that the boundary lubrication film is analogous to the liquid crystal state.

The paper concludes with a reference to the "two-term friction law," which asserts that the tangential force of friction is composed of two terms, one proportional to load and the other to the molecular interaction of the friction surfaces.

Authors do not comment on Bowden's demonstration of the formation of soap films by reaction between certain boundary lubricants and metal surfaces or the possibility of some of their results being attributable to this cause. While the behavior of certain liquids in the vicinity of a surface must be accepted, reviewer is not convinced of the relevance of the work to the modes of boundary friction encountered in practice.

F. T. Barwell, England

5262. Osterle, F., and Saibel, E., Surface deformations in the hydrodynamic slider-bearing problem and their effect on the pressure development, ASLE-ASME Lubr. Conf., Toronto, Ontario, Canada, Oct. 1957, Pap. 57-Lub-3, 11 pp.

5263. Beck, E. J., Jr., Arctic lubrication of diesel engines, ASME Oil and Gas Power Conf., Philadelphia, Pa., May 1958. Pap. 58-OGP-1, 5 pp.

5264. Yoshimoto, G., and Tsukizoe, T., On the mechanism of friction between metal surfaces. 1st report, The influence of surface roughness, Proc. Sixth Japan nat. Congr. appl. Mech., Univ. of Kyoto, Japan, Oct. 1956, 235-238.

Marine Engineering Problems

(See also Rev. 5205)

5265. Alblas, J. B., On the generation of water waves by a vibrating strip, *Appl. sci. Res.* (A) **7**, 2/3, 224-236, 1958.

Flexural vibrations pass horizontally along a strip lying in a vertical plane, representing a long slender ship. An integral equation is obtained for the velocity potential and solved for long waves (shallow draught) similarly to Ursell's treatment, and approximately for short waves (deep draught).

Emphasis is on the mathematical, rather than the physical, problem. Reviewer infers that only if the Froude number, based on velocity and length of flexural waves, exceeds a critical value does surface wave propagation occur. Reviewer does not accept the energy propagation equation (66), although author's assertion that damping is a maximum for the critical Froude number, when the wave crests are perpendicular to the strip, appears to be still true. Outward component of wave velocity is then zero, not infinite, in reviewer's opinion.

A. H. Armstrong, England

5266. Basin, A. M., Investigation of the action of (wave) agitation on a moving ship (in Russian), *Trudi Tsentr. n.-i. in-ta rech. flota* no. 33, 3-42, 1956; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1954.

Article continues author's investigations in which an attempt is made to generalize the solution of the plane problem on the oscillations of a floating plate in a sharply defined shoalwater, given by N. E. Zhukovskii for the case of a liquid of arbitrary depth. It is considered that corresponding formulas for a sharply defined shoalwater can be generalized in the following way:

$$\nu_z = \left(\frac{\partial \zeta}{\partial t}\right) \frac{\operatorname{sh} k(H-z)}{\operatorname{sh} kH} \qquad [1]$$

$$\frac{p-p_0}{\rho} = gz - g\frac{\operatorname{ch} k(H-z)}{\operatorname{ch} kH}\zeta \qquad [2]$$

where ν_z is the vertical component of the velocity, $z = \zeta(x,y,t)$ the equation for the free surface, H the depth of the liquid, p the pressure in the liquid, p_0 the atmospheric pressure, ρ consistency (density) of the liquid, g the acceleration of the gravity force, and k the wave (turbulence) number. The use of the equation of continuity and Euler's equation lead to the wave equation for function ζ:

$$\frac{\partial^2\zeta}{\partial x^2} + \frac{\partial^2\zeta}{\partial y^2} = \frac{1}{c^2}\frac{\partial^2\zeta}{\partial t^2}$$

$$(c^2 = gk^{-1} \operatorname{th} kH)$$

The drift of the vessel is taken into account by transition to a movable system of coordinates, namely by substitution of $\partial/\partial t$ by $\partial/\partial t + v\partial/\partial t$, where v represents the velocity of drift. The remaining components of velocities ν_x and ν_y, and consequently their potential φ depend on z in a form analogous to expression [1], which does not correspond to the actual character of the flow around a floating body, with the exception of the case of a sharply defined shoalwater, when formulas [1] and [2] go over to the expressions adopted by N. E. Zhukovskii. In this case the plane problem becomes unidimensional. Further, use is made of the assumption that under the floating body velocity ν_z is small enough to be disregarded. This assumption is fully justifiable for a clearly marked shallow water, but is physically unjustifiable for an arbitrary depth (of water), and in that category, an infinite depth. On the other side, a purely hydrostatic relation is used to express the relation of the pressure under the floating body $0 = g - \frac{1}{\rho}\frac{\partial p}{\partial z}$ which, even when making use of the condition that $\nu_z = 0$, is found to be acutely contradictory to the earlier accepted expression [2]. In addition, if the connection of expressions [1] and [2] with the correlations of the general linear theory of waves is to be followed up to the end, as the author does partly, then conviction is easy that function ζ depends on time in a fully determined manner. From comparison of Lagrange's integral and expression [2] it follows that velocity potential φ is linked with function ζ by the relation

$$\frac{\partial \varphi}{\partial t} = g\frac{\operatorname{ch} k(H-z)}{\operatorname{ch} kH}\zeta$$

Therefore, from the condition in the free surface when $z = 0$

$$\frac{\partial^2 \varphi}{\partial t^2} - g \frac{\partial \varphi}{\partial z} = 0$$

it follows that function ζ depends on time only through the exponential factor $e^{i\sigma t}$ $(i = \sqrt{-1})$, where $\sigma^2 = gk$ th kH.

The accepted faulty expressions and assumptions lead to a solution which does not convey the hydrodynamic features, which appear when a floating plate is flowed around, in the problem being investigated (large velocities at the edges, continuity of the movement; boundary values of the added mass, and so forth); and that is completely understandable, as actually, in conformity with the accurate theory, the dependence of the velocities and their potentials on z in the form analogous to expression [1] (not counting other mistakes) only occurs at infinitely long distances from the body or even in the case of diffraction of regular waves around an immovable vertical cylinder. M. D. Khaskind

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5267. Fedyaevskii, K. K., Ways of adding precision to the calculations for the towing resistance of a vessel (in Russian), *Trudi Vses. nauch. tekhn. o-va. sudostr.* **6**, 2, 66–73, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1955.

It is shown that the hypothesis that the alteration of geometric similarity during the transition from model to natural conditions does not evoke critical phenomena (cavitation, the breaking away of the boundary layer and so forth), essential for the basis of calculations for the resistance to towing of a vessel, may sometimes fail to be accomplished. In such a case the usual methods of calculation are inapplicable. Some semi-empirical formulas are put forward for the computation of the changes of pressures due to the presence of local projections (for instance, welded seams, etc.). In such a case, if the alteration of geometric similarity only leads to the appearance of some addition to the resistance, then such addition can be divided into a series of components (roughness due to coats of paint, resistance due to wave action, and so forth) and calculated out separately. Author gives formulas for computing such additions. Essentially the article is a summary of practical recommendations regarding the computations for the resistance to towing of vessels. N. N. Moiseev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5268. Fedyaevskii, K. K., Hydrodynamic forces and moments of an inertia nature, acting on the above-water part of a vessel at small Froude numbers. (A simplified deduction of formulae taking into account the asymmetry of the vessel's hull relative to the plane of the amidship frame) (in Russian), *Trudi Leningr. Korablestroit. in-ta*, no. 16, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1948.

5269. Hughes, G., The prediction of smooth ship resistance from model data, *Trans. Instn. nav. Arch. Lond.* **100**, 1, 41–75, Jan. 1958.

A review is given of the results of the work done in recent years in the Ship Division of the National Physical Laboratory on the friction resistance of plane surfaces and the analysis of ship model geosim resistance data.

It is shown that there is a close resemblance between the scale-effect laws for plane surfaces and for a variety of type of hull form over a wide range of Reynolds and Froude numbers. In general the rate of scale effect is a little greater for ship models than for plane surfaces at corresponding values of the viscous resistance coefficient.

Proposals are made for formulations for the correlation of model data in general and for the predicition of smooth ship resistance. From author's summary

5270. Clement, E. P., Scale effect on the drag of a typical set of planing boat appendages, *David W. Taylor Mod. Basin Rep.* 1165, 5 pp. + 1 table + 6 figs., Aug. 1957.

Geometrically similar models of a set of planing boat appendages were manufactured in four different sizes, and tested to determine the scale effect error involved in predicting appendage drag. Data from the test of the smallest appendage set when mounted on a hull model were fairly consistent with data from the three larger appendage sets when mounted on a friction plane. The results indicate that use of an extrapolator which is appreciably steeper than Schoenherr's line at Reynolds numbers below about 10^6 would give more nearly correct predictions of full-scale appendage resistance. From author's summary

5271. Bogdanova, Z. V., Influence of the limited extent of the water channel on the components of water resistance to the movement of a river ship (in Russian), *Trudi Tsentr. n.-i. inta rech. flota*, no. 33, 83–140, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 603.

Results are given for theoretical and experimental investigations of the influence of the limited extent of a waterway (in a canal or in shallow water) on the elements composing the water resistance to the movement of a river vessel. The theoretical determination of the velocity of the flow around the vessel in the channel was based on stream-flow tolerances customarily found in hydraulics. The experimental data were obtained by tests in a tank of a model of a bluff shaped, not self-propelled barge at subcritical velocities of movement. The materials derived from the investigations made it possible to improve the method of recalculation of the resistance of the model in restricted waterway on the actual vessel.

A. A. Kostyukov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5272. Basin, A. M., Investigation of the movement of a ship in a canal (in Russian), *Trudi Tsentr. n.-i. in-ta rech. flota* no. 33, 43–63, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 592.

The problem is examined of the movement of a ship in a canal of limited section in a simplified hydraulic arrangement. Wave formation caused by the ship is not taken into account in the study. The calculated values for the lowering of the water level and the velocity of liquid flow along the side of the ship were obtained on the basis of the equations of continuity of motion and Bernouilli. It was shown that during the movement of the ship in the canal there is a range of critical velocities, the extent of which depend on the degree of constraint due to narrowness of the fairway (i.e. on the relation of the area of the middle rib framework of the ship to the area of the canal section). Cases were examined for subcritical, critical and transcritical velocities of ship movement. Comparison of the results of theoretical calculations with the experimental data gave a satisfactory measure of agreement.

A. A. Kostyukov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5273. Romez, Yu. V., and Khaskind, M. D., Approximate determination of the optimum dimensions of vessels (in Russian), *Izv. Akad. Nauk SSSR, Otd. tekh. Nauk* no. 4, 145–146, 1956; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1964.

Work appears to be a development of the authors' method for an approximate determination of the resistance of water to the movement of ships. A formula is given for the calculation of the viscous and wavy components of resistance through the principal measurements (dimensions) and coefficients of the underwater part of the ship. By means of this formula the optimum dimensions of the vessel can be ascertained. As illustration, curves are brought in to evaluate the specific resistance of vessels at given water displacements and speeds. These curves permit the deter-

mination of the optimum values of the coefficient of longitudinal fullness (beam) of the vessel φ and the relative elongation (length) $l = L/d$ ($d = \sqrt{8\Omega_0/\pi}$) where L is the length of the vessel, Ω_0 the place of the middle rib framework. A. A. Kostyukov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5274. Shultz, J. W., Jr., The ideal efficiency of optimum propellers having finite hubs and finite numbers of blades, *David W. Taylor Mod. Basin Rep.* 1148, 6 pp. + 4 tables + 4 figs., July 1957.

The ideal (nonviscous) thrust coefficient C_{T_i} related to a range of ideal efficiencies (η_i) and a range of advance coefficients (λ) is calculated for propellers having 3, 4, 5, and 6 blades and having hubs whose diameters are 0.2, 0.3, and 0.4 of the propeller diameters. From author's summary

5275. O'Brien, J. T., and Kuchenreuther, J. M., Forces induced on a large vessel by surge, *Proc. Amer. Soc. civ. Engrs.* **84,** WW 2 (*J. Wwys. and Harbors Div.*), Pap. 1571, 30 pp., Apr. 1958.

Field measurements are presented of forces of up to 40,000 pounds as induced by two predominant standing waves—those with 1 and 2 1/2 minute period which produced water surface slopes of up to 0.0015—in the lines of a ship (USS NORTON SOUND (AVM-1)) of 12,000 long tons as moored alongside by unusually taut lines at Port Hueneme, California and near to a node of the shorter wave. The two waves acted simultaneously to produce only significant surge. It is stated that tight lines tend to reduce the inertial force and that the excitation in surge is defined sensibly by the product of the slope of the water surface and the weight of the ship where restoring forces of up to 30,000 pounds in surge as calculated on this basis are about 1/3 greater than those measured. In no case was it considered that resonance was encountered. From authors' summary

5276. Korvin-Kroukovsky, B. V., and Jacobs, Winnifred, R., Pitching and heaving motions of a ship in regular waves, Soc. nav. Arch. mar. Engr., Ann. Meet., New York, Nov. 1957. Advance Pap. 9, 26 pp.

A further refinement to equations of motion of ships in sinusoidal waves. Errors and omissions of 1955 paper by author have been rectified. Motions of eight ship types have been computed and compared with model measurements. Agreement is generally satisfactory and fails only for a yacht form. Theory still requires use of empirical corrections, which apparently are fairly successful. P. Golovato, USA

5277. Lum, S. M. Y., and Walton, C. O., A comparison of pitch measurements on an oscillating towed body using a vertical gyro and a pendulum indicator, *David W. Taylor Mod. Basin Rep.* 1153, 14 pp. + 7 figs., July 1957.

A comparison is made of the relative accuracy of a pendulum indicator as compared with a vertical gyro in determining the pitching motion of a cable-towed body under forced oscillation. It is shown that serious errors are introduced in the measurement of body attitude with a pendulum indicator when the body is subjected to accelerating forces.

From authors' summary

5278. Blagoveshchenskii, S. N., Planning appliances of a new type for the control of loading, stability and settling in cargo ships (in Russian), *Trudi Tsentr. n.-i. in-ta mor. flota* **1,** 1, 36–56, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 596.

5279. Voevodin, N. F., Analytical method for determining the necessary quantity of ballast for lowering the center of gravity of a ship to secure the required stability (to rolling) (in Russian), *Trudi Mosk. tekhn. in-ta ryb. prom-sti i kh-va* no. 6, 96–109, 1954; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1962.

5280. Voitkunskii, Ya. I., and Mellunas, V. F., Investigation of the hydrodynamic features of vessels when in motion under log control and when turning round a vertical axis (in Russian), *Trudi Leningr. Korablestroit. in-ta* no. 14, 74–82, 1954; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1953.

Test results are given for three models under tow. When there was a steady motion of the models (controlled by log) characterized by Froude numbers on a width of 0.3 ÷ 0.34, the amplitudes of hydrodynamic resistance were determined, as well as the heeling moments for a number of constant values for the angles of heeling. It was shown that for such movement the point of intersection of the force direction, acting from the direction of the water to the model, with its diametral plane is to be found between the waterline and the initial metacenter, in which circumstances the position of this point and the amplitude of the coefficient of resistance depend only slightly on the velocity. In addition to this, article contains data regarding the added mass and added moment of water inertia when there is irregular movement of the models without heeling (due to log control) or turning round a vertical axis, passing through the center of gravity. For turning at constant speed the amplitudes of the moments of the hydrodynamic forces are brought in. All these data could be used for calculations of stability (to rolling) when there is jerking by the towline or jerking due to wind action, and also for calculations in connection with the transverse launching of ships, of a type closely corresponding in outline to the models tested.

I. P. Lyubomirov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—5281. Segal', A. I. M., Stability and stiffness of covering for ships (in Russian), Moscow, Rechnoitransport, 1955, 372 pp. + illus., 16r. 80k.; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 914.

Ships' coverings are investigated as systems of intersecting beams, connected at the points of intersection by ball joints. Deformation by shear, which in many cases exercises a large influence, is not investigated.

Author's first concern is concentrated on the question of simplification of the theory, which is also related to the extent and complexity of the calculations. That being so, they are equivalent to those which have to be performed in calculating flat coverings by P. F. Pankovich's method of "principal deflections" [Stroitel'naya mekhanika Korablya, 1941,2]. Chapter I is devoted to the calculation of a covering with one intersection joint and bears the impress of being introductory in character. The main part of the book appears to be chapter II, in which deflections of the covering are examined when several intersecting joints are present. Author deduces the basic equations, omitting the drawing up of a system of differential equations describing the deflections of the coverings being investigated. Making use of the known method of reducing an arched loading to a junction loading, author commences the calculation by the determination of the reactions of the hypothetical rigid supports in the covering joints, after which the calculation is carried out for the coverings on the junction loading. In the simplest case, when the covering rests on a rectangular contour, while all the beams of the principal direction are identically arranged and identically loaded, the calculation to determine the junction loading is made for one beam of the principal direction, resting on a hand support. For instance, for a covering with three intersecting joints three reactions R_1, R_2 and R_3 are determined. Let the moments of inertia of the section of the intersecting junctions be linked with the correlation $I_2 = \lambda I_1$, $I_3 = \mu I_1$, and they are identically fastened on the supports.

Generalized forces P_1, P_2 and P_3 are introduced, linked with the reactions of the correlations

$$P_1 + P_2 + P_3 = R_1$$
$$m_1P_1 + m_2P_2 + m_3P_3 = R_2 \qquad [1]$$
$$n_1P_1 + n_2P_2 + n_3P_3 = R_3$$

where m_1, m_2 and m_3, and n_1, n_2, n_3 are relevant to the determination, and the problem is investigated of the deflection of the covering, loaded with joint loadings, in the ratios of $1:m:n$. If it is assumed that under the action of each of the generalized forces, taken as having been applied to the intersecting joints, the reactions of the beams of the principal structural direction will be found in the same correlation

$$N_1 : N_2 : N_3 = 1 : m : n \qquad [2]$$

then the pointer of deflection of the intersecting joints must be found in the correlation

$$y_1 : y_2 : y_3 = 1 : \frac{m}{\lambda} : \frac{n}{\mu} \qquad [3]$$

As

$$N_i = c_{i1}y_1 + c_{i2}y_2 + c_{i3}y_3 \qquad [4]$$

then condition [2] brings one to the system of two equations

$$m\left(c_{11} + c_{12}\frac{m}{\lambda} + c_{13}\frac{n}{\mu}\right) = c_{21} + c_{22}\frac{m}{\lambda} + c_{23}\frac{n}{\mu}$$
$$n\left(c_{11} + c_{12}\frac{m}{\lambda} + c_{13}\frac{n}{\mu}\right) = c_{31} + c_{32}\frac{m}{\lambda} + c_{33}\frac{n}{\mu} \qquad [5]$$

and, eliminating one of the unknown m or n, author obtains a cubic equation for the other, by means of which determinations are made for all the values of m_1, m_2, m_3 and n_1, n_2, n_3. Utilizing correlation [3] it is possible, on the basis of [4], for instance, to obtain

$$N_1 = y_1\left(c_{11} + c_{12}\frac{m}{\lambda} + c_{13}\frac{n}{\mu}\right) \qquad [6]$$

Having determined also from system [1] the generalized force P_i, it is possible to record a differential equation of the i principal deflection of the first intersecting joint

$$EI_1 y_{1i}^{IV} - \frac{1}{s}\left(c_{11} + c_{12}\frac{m_i}{\lambda} + c_{13}\frac{n_i}{\mu}\right)y_1 = \frac{P_i}{s} \qquad [7]$$

where s is the distance between the beams of the principal structural direction. An unfortunate muddle has to be referred to on pages 83 to 85 in the use of legends, making interpretation reading difficult: by P_i different values are indicated.

In this way, differential equations are obtained for the "principal deflections," by-passing the drawing up and analyses of the system of differential equations. The investigated means of deducing equation [7] is undoubtedly simpler than the original method of P. F. Pankovich, but the same cannot be claimed in regard to other known methods not cited by the author.

It is not possible to agree with the author's assertion that "an important and valuable achievement of the exposition of the method of solution" (p. 87) appears to be the applicability of boundary conditions in every specific case, as this corresponds to the known case of division of the "principal deflections" into boundary conditions. The statement (p. 98) appears to be unreasonable in its assertion that the case of dissimilar support of intersecting joints as shown in P. F. Pankovich's method is a complicated problem, difficult of solution.

In chapter III the case of a complex deflection is examined, the investigation being carried out by application of the method described. First, the case is examined when the longitudinal forces are proportional to the moments of inertia of the cross sections of the intersecting beams, and an accurate solution of the problem is possible; in more complicated cases some variants of approximate solutions are suggested.

In chapter IV the stability of coverings is discussed.

The author wrongly attributes to himself the rigorous solution of the problem on the stability of a bar on evenly placed elastic supports (p. 197), put forward about 30 years ago by Ble'kh ["Teoriya i raschet zheleznykh mostov," Gostraizdat, 1931] and repeatedly used in other works.

Notwithstanding the fact that in chapters II and III the author places some limitations on the applicability of the proposed method of calculation, no such reservations are made in chapter IV, and author introduces a solution which is incorrect in principle (pp. 247 to 252). The similarity of the deflection pointers of the intersecting joints, on which the proposed method is based, is true in the presence of compressive forces, proportional to the moments of inertia of cross sections of the inter-crossing joints, as also in the case of the ends, freely supported, of the intersecting joints, supported on evenly spaced identical transverse joints, when the similarity only concerns the displacements of the joints. [A. A. Kurdyumov, *Inzhenern. sbornik* **4**, no. 1, 1947.]

In chapter V calculations are examined for the cut-off portion and the whole uncut covering, while in the sixth chapter the general theorems and methods of calculation for statically undetermined systems are looked into. Attention is attracted by author's unduly frequent emphasis and high valuation of his own personal results. In the absence of a criticism and references to the extensive literature on the subject of calculations of coverings, a wrong conception of the modern position of the question might arise.

A. A. Kurdyumov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5282. Tachmindji, A. J., and Milam, A. B., The calculation of the circulation distribution for propellers with finite hub having three, four, five and six blades, *Inter. Shipbldg. Progr.* **4**, 37, 467–477, Sept. 1957.

The present report gives the results of calculations for the optimum circulation distribution for propellers having a finite number of blades and finite hub diameters. The calculations were performed for hub diameters of 0.2, 0.3, and 0.4 of the propeller diameters, and a method for interpolating between these values is also included.

From authors' summary

5283. Nebesnov, V. I., Graphical method of analysis of transition movements in an engine-screw-hull system (in Russian), *Nauch. tr. Odessk. in-ta inzh. mor.* no. 12, 38–51, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 608.

When looking into the matter of the principal types of marine engines with screw propellers and the hulls of ships as a single mechanical system, the investigation of the behavior of the ship's engine assembly has to be based on the joint solution of equations for the movement of the engine, screws and hull. To carry out such an investigation by analytical and graphical methods, accepted in the theory of machines, is very intricate. For this reason author puts forward a graphical method of analysis of the behavior of ships' engines, working on screw propellers, where the hull characteristics and the propellers are taken as fixed, while the motive moment is assumed to be a function of the rpm. Such a method permits the solution of the equation of movement of the system to be applied for transitional regimes, such as, for instance, for racing of the screw, for stopping and reversing of the ship and the engine-screw group, for the transition of the whole complex from one regime to another, and permits the determination of the necessary parameters of these movements, such as, for instance, the relative speed of the ship's movement, the change of

the angular velocity of the screw against time, the duration of racing and so forth. The article includes an explanatory example.

A. N. Shmyrev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

5284. Nebesnov, V. I., Apparatus for registering the movements of ships' engines in intermediate (reversible) conditions (in Russian), *Nauch. tr. Odessk. in-ta inzh. mor. flota*, no. 12, 59–66, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1966.

A description is given of the principle of operation and design of a special apparatus, the graphotachometer, made for use in the determination of the power on the roller (shaft) of an engine by the method of free running, and in the control of maneuvring operations of ships' engines in different conditions of working. The analysis of the tachogram, obtained by means of the described apparatus, opens up the possibility of establishing not only the character of the work of the engine, but also the number of its revolutions measured as a function of time. The apparatus can also be used as a mathematical instrument, as it possesses in itself the functions of a cycloidograph and of an ellipsograph.

A. N. Shmyrev

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Letter to the Editor

5285. Conceming AMR **11**, Rev. 1987 (June 1958): **Huffington, N. J., Jr., and Hoppmann, W. H., II, On the transverse vibration of rectangular orthotropic plates.**

Author states "It is noted that the reviewer has indicated a more severe delimitation of the problem than appears in the paper. The paper treats the problem of flexural vibrations of a rectangular orthotropic plate with two opposite edges simply supported and two edges elastically supported; also six special cases corresponding to zero or infinite values of elastic support. The orthogonality criterion for the eigenfunctions and the relations for the kinetic and potential energies are not restricted to this set of boundary-value problems, but apply to any problem of flexural vibrations of rectangular orthotropic plates for which a separation of space and time variables of the form

$$w(x, y, t) = \sum_m \sum_n U_{mn}(x, y)\, q_{mn}(t)$$

may be effected." Reviewer agrees with author.

C. Massonnet, Belgium

Books Received for Review

AKROYD, T. N. W., Laboratory testing in soil engineering, London, G. T. Foulis & Co. Ltd., 1958, vii + 233 pp. 50S.

ALT, F. L., Electronic digital computers, New York, Academic Press Inc., (Applied Mathematics and Mechanics Series, Vol. 4), 1958, x + 336 pp. $10.00.

ASSMUS, FR., Technische Laufwerke einschliesslich Uhren, Berlin, Springer-Verlag, 1958, iv + 279 pp. DM 36.

BOOTH, KATHLEEN H. V., Programming for an automatic digital calculator, New York, Academic Press Inc., 1958, vii + 238 pp. $7.50.

BUDYKO, M. I., The heat balance of the earth's surface, 1956, (translated from Russian by Nina A. Stepanova), Washington, D. C., OTS, (PB131692), 1958, ii + 259 pp. $4.00.

Collected papers presented at the 26th Annual Meeting of the American Society of Tool Engineers, Philadelphia, Pa., Vol. 58, Book I, 1958: Tooling for metal powder parts papers. $5.00.

Collected papers presented at the 26th Semiannual Meeting of the American Society of Tool Engineers, Los Angeles, Calif., Vol. 58, Book II, 1958: Technical papers and panel conferences. $5.00.

FABRI, J., edited by, Air intake problems in supersonic propulsion, 11th AGARD Combustion and Propulsion Panel Meeting, Paris, Dec. 1956, New York, Pergamon Press, 1958, xx + 82 pp. 30s.

GRABBE, E. M., RAMO, S., and WOOLDRIDGE, D. E., edited by, Handbook of automation computation and control, Vol. I, Control fundamentals, New York, John Wiley & Sons, Inc., 1958, viii + 974 pp. + index $17.00.

LANDSHOFF, R. K. M., edited by, The plasma in a magnetic field; a symposium on magnetohydrodynamics, Stanford, Calif., Stanford University Press, 1958, 130 pp. $4.50.

LAP, A. J. W., and VAN MANEN, J. D., Fundamentals of ship resistance & propulsion; Part A, Resistance, Part B, Propulsion, reprinted from *International Shipbuilding Progress Shipbuilding and Marine Engineering*, Rotterdam.

LEKHNITSKI, S. G., Anisotropic plates (translated from the Russian by E. Z. Stowell), New York, American Iron and Steel Institute, 1956, 354 pp.

ONOE, M., Tables of modified quotients of Bessel functions of the first kind for real and imaginary arguments, New York, Columbia University Press, 1958, 338 pp. $12.50.

SCHULER, M., Mechanische Schwingungslehre Teil I Einfache Schwinger, second edition, Leipzig, Akademische Verlagsgesellschaft, 1958, vi + 158 pp. DM 15.

SHTERNFELD, A., Artificial satellites (translation from the Russian under auspices of Technical Documents Liaison Office, Wright-Patterson AFB, Ohio) second revised and extended edition, Washington, D. C., OTS, (PB141351T), 1958, i + 424 pp. $6.00.

STICKLAND, A. C., Executive Editor, Reports on progress in physics, Vol. XXI, London, The Physical Society, 1958, 383 pp.

SYMPOSIUM OF ROCK MECHANICS, Vol. 51, no. 3, Golden, Colorado, Colorado School of Mines, 1956, $2.00.

ZAANEN, A. C., An introduction to the theory of integration, New York, Interscience Publishers, Inc., 1958, v + 254 pp. $7.25.

ZUCROW, M. J., Aircraft and missile propulsion, Vol. II: The gas turbine power plant, the turboprop, turbojet, ramjet, and rocket engines, New York, John Wiley & Sons, Inc., 1958, xiv + 636 pp. $13.00.

ZURMUHL, R., Matrizen Eine Darstellung fur Ingenieure, second edition, Berlin, Springer-Verlag, 1958, viii + 467 pp. DM 33.

Preliminary Announcement

The Fourth U. S. National Congress of Applied Mechanics will be held on the Berkeley campus of the University of California during June 18–21, 1962. The cooperating societies and other interested organizations are urged not to schedule conflicting meetings on these dates.

Research workers in the theoretical and applied mechanics of solids and fluids are invited to submit papers for consideration by the Editorial Committee. Further announcements concerning the preparation of papers and deadlines for submission will be made as the Congress draws nearer.

The members of the organizing committee on the Berkeley campus are:

Professor W. GOLDSMITH, *Secretary*
Professor E. V. LAITONE, *Treasurer*
Professor R. M. ROSENBERG, *Chairman of the Editorial Committee*
Professor W. W. SOROKA, *General Chairman*

Inquiries regarding the Congress should be addressed to Professor W. Goldsmith, Secretary, Division of Mechanics and Design, University of California, Berkeley 4, California.

INDEX OF AUTHORS REFERRED TO IN THIS ISSUE

(NUMBERS USED ARE SERIAL NUMBERS OF REVIEWS)

Abramson, H. N. 4868
Adams, M. C. 5163
Alaka, M. A. 5255
Albers, L. U. 5157
Alblas, J. B. 5265
Alford, E. H. 5085
Allen, H. J. 5061
Al'tshuler, L. M. 5150
Altunin, S. T. 4993
Ambrok, G. S. 5159
Amenzade, Yu. A. 5222
Amen-Zadeh, Yu. A. ...4892
Andreeva, L. E. 4905
Andreiev, O. V. 5000
Anissimov, S. A. ..5032, 5033
Arabadzhi, V. I. 5244
Arnason, G. 5254
Arnaud, P. 4839
Attia, A. Y. 4876
Ayre, R. S. 4846
Azimov, B. A. 5222
Babanov, A. A. 5225
Bainbridge, A. E. 5142
Barrow, H. H. 5146
Barta, J. 4891
Bartlett, R. J. 4932
Base, G. D. 4948
Bashkirov, D. A. 4833
Basin, A. M. 5266, 5272
Bassali, W. A. ...4908, 4909
Beck, E. J., Jr. 5263
Becker, H. 4835
Belin, R. E. 5142
Bennett, J. D. 4931, 4933
Benthem, J. P. 4964
Biedler, W. T., III 5189
Biesel, F. 5073
Biot, M. A. 4979
Blagoveshchenskii, S. N. 5278
Bland, D. R. 4969
Bogdanov, G. G. 5081
Bogdanova, Z. V. 5271
Bolcskei, E. 4949
Boldakov, E. V. 5000
Bonney, E. A. 5112
Borg, M. F. 4911
Bowker, A. J. 5104
Bowser, M. L. 5214
Boyarshinova, A. A. ...5167
Boyce, W. 4853
Branders, H. 4981
Broido, A. 5175
Brooks, G. W. 4863
Brown, J. G. 4997
Browning, A. C. 5086
Browning, J. A. 5240
Bukharinov, G. N. 4922
Bulakh, B. M. 5046
Burgermeister, G. 4925
Burmistrov, E. F. 4923
Burshtein, A. I. 5149
Bushnell, R. H. 5253
Busunov, J. A. 4993
Bystrova, T. A. 5185
Caironi, M. 4943
Calci, P. 5072
Campus, F. 4978
Carpenter, Grace C. ...4836
Castles, W., Jr. 5131
Challoner, A. R. 5186
Chao, B. T. 4982
Chapple, E. W. 5113
Chen, H. S. C. 4838
Chernov, L. A. 5092
Chevalier, J. 5004
Chilton, E. G. 4960
Chone, G. 5154
Chou, P.-Y. 5090
Chu, B.-T. 5162
Chugaiev, R. R. 4991
Clark, R. A. 4917
Clement, E. P. 5270
Clough, R. W. 4889
Colwell, L. V. 4981
Cooper, W. E. 4962
Couchet, G. 5098
Crane, J. F. W. 5086
Creco, L. 5072
Crocco, L. 5139
Csonka, P. 4940, 4941
Culverwell, J. F. 5239
Czerny, G. 5235
Dantu, P. 4929
Dardaganiam, S. G. 5221
de Guenin, J. 5217
Deissler, R. G. 5089
de Jong, H. M. 5252
Demidov, S. P. 4902
Deriagin, B. V. ..5260, 5261
de Villiers, R. C. 5124
Didkoviskii, M. M. 4989
Dimentberg,
F. M. 4858, 4860
Dimtriev, V. N. 4841
Doeinck, E. 4851
Dolidze, D. E. 5006
Draper, L. 5071
Drozd, M. S. 4972
Dronov, A. A. 4955
Dubin, Ch. 5003
Dulácska, E. 4918
Dulnev, V. B. 5010
Dumas, R. J. 5093
Durham, H. L., Jr. 5131
Dyban, E. P. 5174
Dzidziguri, A. A. 5130
Eckhaus, W. 5110
Ede, A. J. 5165
Egiasarian, B. O. 5018
Eichacker, Suzanne S. ..5140
Ellington, J. P. 4898
Elrod, H. G., Jr. 5053
Elworthy, P. H. 5172
Ensing, L. 4845
Evdokimov, P. D. 5220
Faber, S. 4844
Fainzil'ber, A. M. 5247
Falk, S. 4951
Farkas, J. 4937
Farmer, A. 4874
Fauconnier, B. 4998
Favre, A. J. 5093
Fediaevskii, K. K. 5084
Fedarov, E. P. 4992
Fedyaevskii, K. K. 5267, 5268
Ferreira Da Silveira,
A. E. 5148
Ferri, A. 5054
Fiks, V. B. 5173
Filchakov, P. F. 5236
Filimonov, S. S. 5177
Filonenko, L. A. 5042
Filonenko-Borodich,
M. M. 4896
Fine, M. 4828
Fiske, D. L. 5140
Fitzgerald, E. L. 4986
Flemming, H. W. 4996
Ford, H. 4890
Fradkov, A. B. 5156
Fraser, H. R. 5083
Freda, D. 4942
Frederking, T. 5178
Fuess, B. F. 5112
Galezowski, S. H. 5057
Galimov, K. Z. 4915
Galletly, G. D. 4960
Gardner, G. H. F. 4873
Gaviglio, J. J. 5093
Gay, S. M., Jr. 5205
Gaydon, F. A. 4967
Gazarian, Iu. L. 5198
Gelperin, I. I. 5182
Gel'perin, N. I. 5007
Gent, A. R. 4936
Gerathewohl, S. J. 5101
Gershuni, G. Z. 5168
Ghali, A. 4961
Ghul', K. K. 5249
Gibson, F. C. 5214
Ginevskii, A. S. 5084
Gladwell, G. M. L. 4907
Glassman, I. 5056, 5139
Gledt, W. H. 5144
Glukhovskii, B. Kh. 5074
Goder, W. 4926
Godridge, A. M. 5196
Goldstein, A. W. 5195
Gorshkov, N. F. 5201
Govinda Rao, N. S. 4999
Granholm, P. 5203
Grant, W. L. 5124
Grassmann, P. 5178
Greco, C. 4942
Gregory, A. R. 4873
Greenberg, R. 4831
Griffith, J. E. 4977
Grounds, P. W., Jr. 5239
Gumenyuk, V. S. 4856
Gundry, H. A. 5186
Hajdin, N. 4879
Hak, J. 5155
Hall, A. W. 4877
Hall, H. 5113
Hall, J. A. 5143
Halpern, C. 5190
Handelman, G. 4853
Harder, K. C. 5095
Harpur, N. F. 4950
Hartmann, M. J. 5195
Hartree, D. R. 5171
Hatta, H. 4901
Hauschild, W. 5241
Hausrath, A. H., III ...4875
Heisenberg, W. 5094
Hemp, W. S. 4952
Heyson, H. H. 5100
Higuchi, S. 4852
Hill, R. 4966
Hiltscher, R. 4959
Hodge, P. G., Jr. 4910
Hoelscher, H. E. 5189
Hoge, H. J. 5140
Horlock, J. H. 5135
Howard, L. N. 5020
Howes, W. L. 5200
Hug, M. 5004
Hughes, G. 5269
Hult, J. A. H. 4968
Huss, P. O. 5253
Idelchik, I. E. 5230
Idzerda, H. H. 4845
Iinuma, K. 4852
Imai, I. 5161
Ipatova, Z. D. 5012
Irwing, W. 4872
Isaakyan, S. M. 5013
Iskritskii, D. E. 4970
Jackel, H. 5147
Jacobs, Winnifred R. ...5276
Jacobsen, L. S. 4846
Jain, V. K. 5211, 5212
Janssens, P. 5091
Jarre, G. 5137
Johnson, A. E., Jr. 4935
Johnson, K. L. 4887
Johnson, W. R. 5197
Jones, R. 4946
Julius, R. S. 4854
Jung, R. 5243
Kaattari, G. E. 5052
Kadirov, N. B. 5183
Kagan, B. M. 4834
Karagunis, A. 5178
Karasev, V. V. 5261
Katzoff, S. 5100
Kaul, R. K. 4934
Kelarev, Yu. I. 5031
Kereselidze, N. B. 5238
Kertesz, J. 5187
Kevorkian, J. 5131
Khakivo, M. Kh. 5223
Khaskind, M. D. 5273
Khilchevsky, V. V. 4975
Khivinya, M. V. 4862
Khrustalev, B. A. 5177
Kingsbury, E. P. 5258
Kirsanov, N. N. 4956
Kiselev, P. J. 5029
Kislev, P. G. 4995
Kissel, R. 5145
Klapproth, J. F. 5195
Kloppel, K. 4926
Klunker, E. B. 5095
Klyachko, L. S. 5122
Koch, W. 5179
Konakov, P. K. 5177
Kondrat, K. I. 5021
Koopman, K. H. 4939
Kopp, J. 5178
Korenov, B. G. 4886

INDEX OF AUTHORS REFERRED TO IN THIS ISSUE *(Continued)*

(NUMBERS USED ARE SERIAL NUMBERS OF REVIEWS)

Korvin-Kroukovsky, B. V. 5276
Kostin, A. I. 5034
Kotova, L. I. 5259, 5260
Kovacs, L. 5246
Kovasznay, L. S. G. ... 5162
Krasil'nikov, V. A. 5209
Krolevetz, M. S. 4928
Krzywoblocki, M. Z. v. .. 5058
Kuchenreuther, J. M. .. 5275
Kudriavtsev, E. V. 5152
Kudryashev, L. I. 5180
Kuljian, H. A. 4838
Kunin, N. F. 4976
Kuo, H.-L. 5256
Kurdin, N. S. 4920
Kuskov, L. S. 4994
Kutateladze 4895
Kviatkovskii, V. S. 5126
Lamb, G. G. 5239
Lambourne, N. C. 5109
Lanczos, C. 4825
Lang, H. A. 4871
Laporte, O. 5197
Lay, J. E. 5043
Lazarev, V. P. 5261
Leaver, Vera M. 5143
Lebedev, L. L. 5040
Leczfalvy, S. 5224
Lee, J. A. N. 4914
Legg, K. L. C. 4965
Leinard, P. 5202
Le Mehaute, B. 5073
Leonkov, A. M. 5005
Liamshev, L. M. 4916
Lianis, G. 4890
Lieber, P. 4874
Likhtman, V. I. 4985
Lin, C. C. 5028
Linevsky, A. A. 5218
Lineykin, P. S. 5169
Linnell, R. D. 5062
Liptak, L. 4954
Lock, R. C. 5055
Loeffler, A. L., Jr. 5089
Lohner, K. 5154
Lown, H. 5117
Lubny-Gertsyk, A. L. .. 5176
Ludi, L. H. 5132
Ludwig, G. 4832
Lum, S. M. Y. 5277
Maestrello, L. 5208
Maglieri, D. J. 4863
Magnus, K. 4847
Marin, J. 4977
Markham, B. G. 5102
Mason, C. M. 5214
Mathur, P. N. 5067
Matschinski, M. 4850
Mayhew, Y. R. 5133
McCallion, H. 4898
McGoldrick, R. T. 4867
McKay, J. M. 4877
McNeill, R. L. 5217
Meier-Dornberg, K.-E. .. 4904
Meilunas, V. F. 5280
Melese, G. B. 5138
Melik-Nubarov, S. G. .. 5009
Merk, H. J. 5193, 5194
Merkulov, L. G. 5210
Mesmer, G. 4930
Metsugov, V. Kh. 4894
Mettler, E. 4855
Metzmeier, E. 4857
Michel, V. M. 5257
Milam, A. B. 5015, 5282
Miles, J. W. 5114
Miller, D. R. 4962
Minhinnick, I. T. 5108
Minsker, K. S. 5182
Miropolskii, L. 5158
Mitra, M. 4870
Mizrahi, J. 5141
Moffitt, T. P. 5125
Mohan, R. 4984
Molyneux, W. G. 5111
Monaghan, R. J. 5086
Morgan, W. B. 5015
Morkovin, M. V. 5087
Moss, C. E. 5120
Mueller, J. N. 5096
Muller, K.-H. 5019
Murphy, G. 4875
Myshkis, A. D. 4848
Naake, H. J. 4869
Napetvaridze, Sh. G. 5248
Nassif, M. 4908
Nazarchuk, M. M. 5127
Nazarov, A. A. 4921
Nebesnov, V. I. .. 5283, 5284
Nee, L. P. 5228
Nelson-Skorniakov, F. B. 5237
Nicolay, B. L. 4859
Nielsen, J. N. 5052
Nietsch, H. E. 4988
Nishida, Y. 5219
Norbury, J. F. 4830
Norden, P. V. 4827
Nowinski, J. 4897
Nuttall, H. 4967
Oberhettinger, F. 4823
O'Brien, J. T. 5275
Ogilvi, A. A. 5231
Olberts, D. R. 4983
Ollos, G. 5233, 5234
Osterle, F. 5262
Ostrach, S. 5157
Ostrowski, J. 5002
Oswatitsch, K. 5059
Pailloux, H. 4849
Pant, B. 4959
Panteleev, N. I. 5128
Parkin, P. H. 5199
Patterson, R. C. 5245
Paul, B. 5213
Pavlovskii, S. S. 4990
Pearce, C. E. 4864
Perel'man, R. G. 5011
Perrin, J. R. 5192
Peterson, P. W. 4875
Pierre, B. 5027
Pitts, W. C. 5052
Platt, A. 4830
Platthy, P. 4957
Pocock, P. J. 5104
Polin, Kh. M. 4994
Polyushkov, A. G. 5039
Ponomarev, V. D. 5228
Powell, R. W. 5186
Power, G. 5049
Prelog, E. 4878
Price, E. 5105
Prickl, G. 5215
Probstein, R. F. 5163
Push, V. 4984
Radisnov, J. A. 4989
Radke, A. O. 4865
Ramberg, L. K. 4872
Ramberg, W. 4866
Ransford, G. 4839
Ranta, S. 4854
Ranz, W. E. 5242
Rao, G. V. R. 5051
Rase, H. F. 5146
Raymondi, C. 4884
Remez, Yu. V. 5273
Reshotko, E. 5164
Resinger, F. 4885
Resnick, W. 5141
Reynolds, C. E. 4899
Ripperger, E. A. 4868
Ritchie, J. 5120
Ritter, O. L. 5101
Roberson, R. E. 5251
Rodionov, B. L. 5077
Rogers, G. F. C. 5133
Roi, N. A. 5014
Roik, K. 4945
Rollnik, H. 4832
Romanenko, S. V. 5184
Rose, P. H. 5163
Rosenberg, M. D. 5227
Sacks, G. M. 5025
Sadovskaya, N. N. 5030
Saelman, B. 4900
Sagomonian, A. Ya. 5068
Saibel, E. 5262
Salion, V. E. 4953
Salisbury, J. K. 5136
Sankaranarayanan, R. .. 4910
Sanyal, L. 5038
Saunders, O. A. 5165
Savarenskii, E. F. 5078
Savruk, M. A. 4880
Sawyer, R. H. 4877
Saxl, K. 4987
Schleeh, W. 4919
Schleicher, F. 4924
Schmidt, M. 5001
Scholes, W. E. 5199
Scholz, N. 5116
Schutzmann, M. E. 5181
Schwab, R. H. 4963
Schwez, I. T. 5174
Scott, F. H. 5214
Scruton, C. 5109
Sedov, L. I. 4822
Seed, H. B. 5217
Segal', A. I. M. 5281
Self, L. 5045
Shamovskii, B. Ya. 5069
Shanley, E. S. 5192
Shanshiashvili, A. M. .. 4927
Shashkov, A. G. .. 4840, 4841
Shercliff, J. A. 5044
Shestakov, V. M. 5229
Shinbrot, M. 4836
Shitsman, M. E. 5158
Shklovskaia-Kordi, P. P. 5209
Shorin, V. G. 5031
Shultz, J. W., Jr. 5274
Shumakov, N. V. .5151, 5152
Silveira, M. A. 4863
Silveston, P. L. 5166
Singh, B. R. 4864
Skladnev, U. F. 5080
Slavin, M. Ya. 4944
Slavyanovich, V. Ya. ... 5076
Smith, I. E. 5139
Smith, P. 5049
Snyder, C. M. 5070
Sodha, M. S. 5211, 5212
Sokolovsky, V. V. 5216
Solomiansky, M. 5141
Sorokina, A. I. 5170
Sovran, G. 5118
Spears, C. A. 4842
Speidel, L. 5116
Sretenskii, L. N.. 5075, 5207
Stallings, H. D., Jr. 5101
Stephenson, J. M. 5060
Stepniewski, W. Z. 5103
Sterrett, J. R. 5123
Steup, H. 4925
Stevens, G. 4965
Stevens, W. F. 5239
Stewartson, K. 5022
Strohl, H. 4843
Stuart, J. T. 5088
Styrikovich, M. A. 5181
Sukhin, L. T. 4976
Summers, C. R. 5214
Sutton, G. W. 5064
Tabachnikov, L. Ya. ... 5129
Tachmindji, A. J. 5282
Takeda, S. 4837
Tamm, K. 4869
Tanner, L. H. 5097
Tao, L. N. 5026
Taraporewalla, K. J. ... 4913
Taylor, E. S. 4829
Taylor, G. 5226
Tchankvetadze, G. G. .. 4888
Tchkhikvadze, G. M. .. 4893
Tchudinov, A. A. 5170
Tempelmeyer, K. E. ... 5045
Templeton, H. 5115
Tendeland, T. 5160
Tewari, S. G. 4934
Thiry, R. 4929
Thurlow, G. G. 5196
Titchmarsh, E. G. 4824
Toth, J. 5246
Trigger, K. J. 4982
Trifonov, E. K. 5008
Trofimov, V. I. 4974
Troskolanski, A. T. 5023
Trostel, R. 4882
Truesdell, C. 4903
Tsai, S.-T. 5090

(Continued on outside back cover)

INDEX OF AUTHORS REFERRED TO IN THIS ISSUE *(Continued)*

(NUMBERS USED ARE SERIAL NUMBERS OF REVIEWS)

Tseitlin, A. S. 5017
Tsikunov, V. A. 5250
Tsukizoe, T. 5264
Turner, R. C. 5120
Ulitsky, I. I. 4947
Urbain, G. 5145
Uvarov, V. V. 5121
Vaisman, M. D. 5134
Valentine, E. F. 5047
Val'ter; L. L. 4970
Van der Hegge Zijnen,
B. G. 5035, 5036, 5037
Van Dyke,
M. D. ...5048, 5063, 5099
Van Itterbeek, A. 5204
Varley, E. 5082
Vasilishin, T. M. 5012
Veiler, S. Ia. 4985
Vessey, E. 5235
Vicolovius, R. 4826
Vilenskii, Ya. G. 5074
Vil'nits, S. A. 5007
Vinogradov, A. I. 4973
Vishnevsky, K. P. 5180
Visioli, F. 5072
Vladislavlev, L. A. 5016
Vlasov, K. P. 5188
Voevodin, N. F. 5279
Voitkunskii, Ya. I. 5280
Volmir, A. S. 4906
Voshchinin, A. P. 5232
Waldron, H. F. 5066
Walter, H. E. 4883
Walton, C. O. 5277
Watkins, J. 5119
Webster, C. T. 5191
Wegner, U. 4980
Weigand, A. 4861
Westerwick, R. 5105
Widmayer, E., Jr. 4963
Wiegel, R. L. 5070
Wiesner, F. J., Jr. 5117
Williams, J. E. 5070
Willis, D. R. 5056
Willoughby, A. B. 5175
Winterberg, F. 5153
Wood, W. W. 5024
Woodcock, D. L. 5108
Woods, L. C. 5050
Wyllie, M. R. J. 4873
Yakoob, B. M. 5041
Yoshimoto, G. 5264
Yudin, E. Ya. 5206
Zabludovskii, V. M. 4912
Zaid, M. 5213
Zakhavseva, N. N. 5261
Zarembo, L. K. ..5079, 5209
Zaytsev, V. P. 4971
Zbrozek, J. K. 5106
Zee, C.-H. 4958
Zhitkov, P. N. 4881
Zienkiewicz, H. K. 5065
Zink, J. 5204
Zisner, T. 5141